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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

July 23, 1964

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Includes administration and management; space law and related legal matters; legislative hearings and documents; and symposia or conferences of a broad or general nature

N64-20783* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PROCEEDINGS OF THE NASA-AEC LIQUID-METALS CORROSION MEETING, VOLUME I

Washington, NASA, 1964 292 p refs Held at Lewis Res. Center, Cleveland, Oct. 2–3, 1963

(Sponsored by NASA and AEC)

(NASA SP-41) OTS: $5.00

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N64-20816* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SPACE PROGRAMS SUMMARY NO. 37-26, VOLUME IV FOR THE PERIOD FEBRUARY 1, 1964 TO MARCH 31, 1964. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT

R. Broucke et al 30 Apr. 1964 280 p refs

(Contract NAS7-100)

(NASA CR-56175; JPL-SPS-37-26, Vol. 4) OTS: $12.50

Areas discussed are: (1) systems analysis (trajectory and launch probability studies, etc.); (2) spacecraft electrical power; (3) guidance and control analysis and integration; (4) guidance

and control research; (5) materials research; (6) electrochemical engineering support; (7) aerodynamic facilities; (8) solid-propellant engineering; (9) polymer research; (10) propulsion research; (11) advanced propulsion engineering; (12) space-instruments systems; (13) applied science (electron-excited X-ray fluorescence for lunar-surface analysis and the Rutherford experiment); (14) chemistry; (15) fluid physics; (16) physics; (17) communications-elements research; and (18) communications-systems research. I.v.L.

N64-20820 Joint Publications Research Service, Washington, D.C.

NEW ACHIEVEMENTS IN SOVIET AVIATION DESIGN

A. Yakovlev 25 May 1964 6 p Transl. into ENGLISH from Krasnaya Zvezda (Moscow), 17 Apr. 1964 p 4

(JPRS-24731; OTS-64-31316) OTS: $0.50

Developments in Soviet aviation are outlined from the advent of the first jets to modern planes that fly with speeds exceeding 3,000 km/hr. New surface combat equipment and aircraft are also described. R.T.K.

N64-20829 Joint Publications Research Service, Washington, D.C.

FROM AIRPLANE TO SPACESHIP: NOTES OF AN ASTRONAUT FLIGHT INSTRUCTOR

Ye. Yevseyev 19 May 1964 10 p Transl. into ENGLISH from Aviats. i Kosmonavt. (Moscow), no. 2, Feb. 1964 p 58–63

(JPRS-24660; OTS-64-31286) OTS: $0.50

This report describes conversations between the flight instructor and the astronauts. These conversations were aimed at encouraging self-analysis and the critical evaluation of other astronauts. Hobbies are also discussed. I.v.L.

N64-20892 Lockheed Missiles and Space Co., Sunnyvale, Calif.

SYSTEMS ENGINEERING Annotated Bibliography

George R. Evans, comp. Apr. 1963 47 p refs

(Contract NOw-63-0050)

(SB-63-12; Special Bibliog. 8-40-63-3; AD-439441)

This bibliography is limited to reports, most of them classified, concerned with the technical problems of systems engineering in space and weapon projects. It is highly selective and representative of the research done in this area, but is by no means exhaustive. G.D.B.

N64-20924 Joint Publications Research Service, Washington, D.C.

TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY, NO. 83

13 May 1964 116 p refs Transl. into ENGLISH from Chinese Publ.

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N64-20949* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

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17. APPLICATION OF THE TWO FIXED CENTER PROBLEM TO LUNAR TRAJECTORIES M. Payne (Republic Aviation, Inc.) p 323–327 (See N64-20966 14-29)

N64-21091 Human Sciences Research, Inc., McLean, Va.
THE DEVELOPMENT OF AN INFORMATION SYSTEM FOR IDENTIFICATION AND RAID RECOGNITION IN AIR/SPACE DEFENSE. VOLUME I: INITIAL STEPS Final Report
W. S. Vaughan, Jr. and T. R. Virnelson Bedford, Mass. AF Systems Command, Electron. Systems Div., Jul. 1963 76 p refs
(Contract AF 19(628)-289)
(ESD-TDR-64-189, Vol. 1; AD-600538)

The system development process is a methodology, essentially a series of steps or decisions for translating an expression of a functional need into a system-in-being. For the most part, the process of system development is a not-well-understood art—no explicit statements of how to do it exist. This lack of systematic procedures is particularly noticeable in the early stages of system development where the expression of functional need is initially reduced to a concept of how the requirements will be solved. In later stages of system development, where problems such as man–machine task allocations and operator–console interface relationships must be solved, some guidance is available to system developers in the form of data descriptive of human capabilities to read displays, discriminate auditory signals, reach various distances, apply certain forces, etc. The purpose of the present study was to take an initial step toward specifying a methodology and providing a set of guides to structure the early stages of future system development. Author

N64-21136* National Aeronautics and Space Administration, Washington, D.C.
PROCEEDINGS OF THE CONFERENCE ON THE LAW OF SPACE AND OF SATELLITE COMMUNICATIONS
1964 212 p refs A Part of the 3rd Natl. Conf. on the Peaceful Uses of Space, Chicago, May 1–2, 1963; held in co-operation with Northwestern U.
(NASA-SP-44) GPO: $1.50

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N64-21137* Yale U., New Haven, Conn.
THE EMERGING CUSTOMARY LAW OF SPACE
Myres S. Mc Dougal *In* NASA, Washington Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 2–33 refs (See N64-21136 14-01) GPO: $1.50

Among nations, some consensus of space law exists today; most aspects are still vague and ill-defined. However, discussions are taking place on the following aspects of space law: (1) authority for resolving controversies; (2) inclusive access to the domain of space; (3) responsibility for space activities; (4) exclusive competence in space; (5) boundary problems of outer space and airspace; (6) preservation of peace; (7) torts and crimes; (8) space resources; (9) conduct of space business; and (10) contact with extraterrestrial life. G.D.B.

N64-21139* National Aeronautics and Space Administration, Washington, D.C.
THE "FREEDOM" OF OUTER SPACE: SOME PROBLEMS OF SOVEREIGNTY, CONTROL, AND JURISDICTION
John A. Johnson *In its* Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 34–57 (See N64-21136 14-01) GPO: $1.50

On the basis of developments over the past 5 1/2 years, the conclusion is made that the nations of the world have not regarded territorial sovereignty—that is, their power of unilateral exclusion—as extending to the point of artificial

satellite orbits. The boundary problem of outer space and its implications for manned space flight and orbiting satellites are discussed. R.T.K.

N64-21140* State Dept., Washington, D.C.
INTERNATIONAL ORGANIZATION AND SPACE
Abram Chayes *In* NASA, Washington Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 58–76 (See N64-21136 14-01) GPO: $1.50

The legal subcommittee of the Committee on Peaceful Uses of Outer Space is working on general principles to be submitted to the United Nations as a guide for regulating outer space exploration. Resolution 1721 of the 16th General assembly has laid the groundwork for international regulation of space activities. The International Telecommunication Union has allocated radiofrequencies for operating space communication. G.D.B.

N64-21141* Volpe and Boskey, Washington, D.C.
MONOPOLY AND ANTITRUST ASPECTS OF COMMUNICATIONS SATELLITE OPERATIONS
Bennett Boskey *In* NASA, Washington Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 80–110 refs (See N64-21136 14-01) GPO: $1.50

The monopoly and antitrust aspects of activities to be carried out under the Communications Satellite Act of 1962 are discussed. The aspects of this legislation that are likely to give rise to controversy are outlined. Also discussed are the regulatory system, checks and balances, procurement matters, foreign negotiations, service rates, and the role of Congress in respect to this legislation. R.T.K.

N64-21142* Northwestern U., Evanston, Ill.
REGULATION IN ORBIT: ADMINISTRATIVE ASPECTS OF THE COMMUNICATIONS SATELLITE ACT OF 1962
Victor G. Rosenblum *In* NASA, Washington Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 111–153 refs (See N64-21136 14-01) GPO: $1.50

Examination of the Communications Satellite Act from administrative perspectives suggests three broad problem areas for analysis. The first relates to clarity of draftsmanship and demands a detailed exploration of the ambiguities, intentional and otherwise, that are found in the act. The second focuses on the role of the Executive, who is given unprecedented power in a peacetime measure. The third centers on the conflicts that may arise among the various agencies and departments that have a role to play in the administration of the act. R.T.K.

N64-21143* Michigan U., Ann Arbor
SOME INTERNATIONAL ASPECTS OF COMMUNICATIONS SATELLITE SYSTEMS
Samuel D. Estep *In* NASA, Washington Proc. of the Conf. on the Law of Space and of Satellite Communications 1964 p 154–196 refs (See N64-21136 14-01) GPO: $1.50

Some of the problems that will be faced in making policy decisions concerning establishment of the communications satellite system are presented. Some of the legal problems that may arise from the international negotiations necessary to establish this service are discussed. Various legal, economic, and political aspects of the communications satellite system are also discussed. R.T.K.

N64-21174 Naval Ordnance Test Station, China Lake, Calif. Weapons Development Dept.
FIXED-WEIGHT AND FIXED-VOLUME CONSTRAINTS ON OPTIMUM CHARGE-TO-METAL RATIOS
Robert G. S. Sewell Mar. 1964 13 p
(NAVWEPS-8471; NOTS-TP-3430; AD-435847)

A simplified method of determining optimum charge-to-metal ratios in warheads under the design limitations imposed by either a fixed weight or a fixed volume is discussed. Equations are developed for optimum ratios for producing maximum momentum, energy, or another function of mass and velocity for two charge geometries. Curves of these functions, showing behavior in the vicinity of the maxima, are presented. Author

N64-21180 Air Force Systems Command, Griffiss AFB, N.Y. Rome Air Development Center
CLASSIFIER – AN AUTOMATED COMPUTER-ORIENTED INFORMATION CLASSIFICATION SYSTEM
John B. Mc Lean and Edward Morenoff Feb. 1964 17 p refs
(RADC-TDR-64-14; AD-434768)

CLASSIFIER is an automated computer-oriented information classification system which provides a library structure for information as well as document retrieval. The information content of the document is classified at levels of detail ranging from the document to a sentence. Statistically determined measures of relevance indicative of the degree of association of each unit of information with respect to each class of the hierarchy are defined. The result is a series of lists of units of information for each class of the hierarchy, rated in order of decreasing relevance. Inherent in the classification process is the ability to select index terms for the units of information to complement the hierarchical structure. Nonstatistical measures can supplement the statistical techniques if desirable. Author

N64-21299 Aerospace Medical Div. Personnel Research Lab., Lackland AFB, Tex.
EFFECT OF SORTING PROCEDURE ON ACCURACY OF ORDINAL RANKING
Joseph M. Madden, Joe T. Hazel, and Roger D. Bourdon Jan. 1964 8 p
(PRL-TDR-64-1; AD-433056)

Although ranking is often used by research personnel and by others working in supervisory and management situations, there has been practically no development work done on the method itself. Many techniques for accomplishing rank-ordering are devised, but their efficacy is rarely tested. To determine the most effective sorting procedure to arrive at accurate rankings, a task was selected that permitted an objective measure of error. Fifty-four cards were prepared that showed pairs of circles differing in area by graduated amounts. The task was to order the cards by size of difference in circle area. Five samples of 52 airmen were each directed to sort the cards by one of five methods. Four methods were structured in varying degrees; in the fifth, subjects were free to sort as they pleased. Analysis of variance demonstrated significant differences between methods. The free-sort method yielded the least average error, suggesting that for judgments of the type used in this study, there is no gain in accuracy of ranking from specifying the method of sorting. Author

N64-21349 Burroughs Corp., Detroit, Mich.
GEMINI PROJECT PROGRAM PLAN FOR THE LAUNCH VEHICLE GUIDANCE COMPUTER
17 May 1963 24 p
(Contract AF 04(695)-28)
(AD-431251)

This report includes: (1) a list of the following critical items and their delivery dates—the A-1 modification kit, the data exchange unit, the test conductors panel, the guidance

monitor console, facility modification, the A-1 program, the A-1 wire list and answer package, A-1 program packages, and system interconnection and checkout; (2) the appropriate tests and procedures for the above listed deliverable items; and (3) milestone charts showing schedules for the following tasks of the work program and subsequent communications—the program plan, the development and maintenance of the computer program, technical liaison; the operation and maintenance of the A-1 computer system, documentation, reports, the reliability and quality assurance program, and modification to the MOD III (A-1) computer system at AMR. Also, a diagram of the Gemini launch vehicle guidance and control subsystem is presented, and program management and facilities are discussed. I.v.L.

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc. *For related information see*: 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 11 Fluid Mechanics.

N64-20777 Joint Publications Research Service, Washington, D.C.

HYDRODYNAMICS OF A LOW-ASPECT-RATIO WING

In its Control and Stability in Ship Design 12 May 1964 p 9–69 refs (See N64-20776 14-11) OTS: $6.00

Among the topics discussed are the following: (1) the theory of a wing with a finite aspect ratio; (2) theoretical premises for constructing the theory of a low-aspect-ratio wing; (3) calculation of low-aspect-ratio wings by the horseshoe-vortex method; (4) approximation solution of an integral-differential equation for a very-low-aspect-ratio wing; (5) hydrodynamic forces and moments acting on a minimum-aspect-ratio wing making a steady-state turn around a circle; (6) nonlinearity of characteristics of a low-aspect-ratio wing; (7) approximate nonlinear (circulation) theory of a low-aspect-ratio wing; and (8) a semiempirical method of considering the nonlinearity of the hydrodynamic characteristics of a wing (circulation-spillover theory). R.T.K.

N64-20838 ARO, Inc., Arnold Air Force Station, Tenn.

BASE DRAG MEASUREMENTS ON AN OGIVE-CYLINDER MODEL WITH BASE NOZZLE FLOW

D. K. Graham and T. W. Binion, Jr. Arnold Eng. Develop. Center, May 1964 21 p refs

(Contract AF 40(600)-1000)

(AEDC-TDR-64-87; AD-439632)

The base drag characteristics of a missile model with a concentric booster and sustainer nozzle arrangement were investigated in the Mach number range from 0.7 to 1.5 in an aerodynamic wind tunnel. Sustainer nozzle total pressure was varied up to 300 psi using nitrogen as the nozzle fluid. Data were obtained to determine the effect of position and diameter of the sustainer nozzle and base bleed on base drag. Results of the investigation indicate that a base drag reduction can be obtained by positioning the sustainer nozzle exit downstream of the model base. Base drag was also reduced by introducing bleed flow into the booster nozzle cavity. Author

N64-20883 Canadian Armament Research and Development Establishment, Valcartier

RADIATION PHENOMENA IN NON-EQUILIBRIUM SHOCK LAYERS OF BLUNT BODIES IN HYPERSONIC FLOW

D. Ellington May 1964 47 p refs Presented at the Can. Aeron. and Space Inst., Astronautics Symp., Ottawa, 13–14 Feb. 1964

(ARPA Order 133)

(CARDE-TR-496/64)

Radiation phenomena exhibited by blunt projectiles traveling at hypersonic speeds are discussed, with emphasis on the nonequilibrium aspects of these phenomena. A model is described leading to the formulation of a system of equations governing the shock-layer flow, including the effects of finite rate chemistry. These equations are solved numerically on a digital computer, and the resulting flow-field solutions are used as a basis for calculations of gaseous radiation, including radiative relaxation effects. Results are compared with experimental measurements made on the CARDE hypersonic ranges. Author

N64-20884 Canadian Armament Research and Development Establishment, Valcartier

BINARY SCALING LIMITS FOR HYPERSONIC FLIGHT

D. Ellington May 1964 19 p refs

(ARPA Order 133)

(CARDE-TR-499/64)

Shock layers of blunt bodies in hypersonic flight are studied with regard to thermodynamic, chemical, and radiative effects, to establish limits on the ranges of validity of binary scaling laws. An approximate analysis for the hypersonic shock layer is employed, and results are compared with scaling limits established by other investigators. It is concluded that the limitations on scaling may not be as severe as previously reported. Author

N64-21001 France. Office National d'Études et de Recherches Aeronautiques, Chatillon-sous-Bagneux

CONTRIBUTION TO THE STUDY OF SUPERSONIC EJECTORS [CONTRIBUTION A L'ETUDE DES EJECTEURS SUPERSONIQUES]

Maurice Sirieix [1960] 20 p refs In FRENCH Presented at Assoc. Tech. Maritime et Aeron., Paris, 27–30 May 1963

(TP 32(1963))

An investigation of flow in a dual-flow ejector revealed different functional regions, which have been confirmed by theory. One region corresponds to the discharge of the secondary flow following a quasi-isobaric mixing with the principal flow; the other region corresponds to the more important secondary flows. The calculation of the discharge behavior, when the secondary flows are weak, may lead to the utilization of the fundamental studies of reattachment by means of a slight modification of the customary method. I.v.L.

N64-21079 Princeton U., N. J.

MASS FLOW THROUGH A CIRCULAR ORIFICE AND A TWO-DIMENSIONAL SLIT AT HIGH KNUDSEN NUMBERS

D. R. Willis Mar. 1964 31 p refs

(Grant AF-AFOSR-112-63; Contract Nonr-222(45))

(Rept. 683; AFOSR-64-0858; AD-600968)

The local and total mass flow through a circular orifice and a two-dimensional slit with very low downstream pressure is calculated for large Knudsen number. The solution is obtained by performing one iteration on an integral equation form of the kinetic equation, starting with the free molecular solution for the distribution function. A relaxation-type model

is used to describe the intermolecular collisions. There is found to be a variation of approximately 40 percent in the local mass flow perturbation (from the free molecular value) across the orifice. For the slit, the variations are smaller when the Reynolds number is less than 0.3, but are comparable for greater values. Author

N64-21109 ARO, Inc., Arnold Air Force Station, Tenn.
EXPANSIVE FLOW TABLES PERTINENT TO JET FLOW CALCULATIONS
S. C. Lyons Arnold Eng. Develop. Center, Apr. 1964 313 p
(Contract AF 40(600)-1000)
(AEDC-TDR-64-73; AD-435420)

Charts and tables are presented for determining approximate values of the initial turning angles and the boundary shapes of jets exhausting to low ambient temperatures. The tables were compiled to facilitate calculations pertaining to jet flow for various ratios of specific heats from 1.10 to 1.667 and Mach numbers from 1.0000 to 100.00. The ratios p/p_t and A/A^* and the Prandtl–Meyer angle are given for each Mach number and ratio of specific heats. Author

N64-21159 General Motors Corp., Santa Barbara, Calif. Defense Research Labs.
HYPERVELOCITY RANGE RESEARCH PROGRAM Semi-Annual Report, 30 Jun.-31 Dec. 1962
Jan. 1963 38 p refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(GM-TR-63-202; AD-296109)

Optical and radar target-detection and identification phenomena were investigated by studying firings, in the hypervelocity range, of spheres and cylindrical bodies with hemispherical nose sections. The total number of rounds fired was 204, of which 85% yielded useful results. The velocities ranged from less than 10,000 fps to above 25,000 fps, with pressures varying from 100-mm to 1.0-mm Hg. A variety of measurements were taken of each round. These included shadowgraphs, optical radiation records, high-infrared-radiation records, transverse-path microwave records, and Doppler radar measurements. Schlieren photos were taken, and a limited number of flash X-ray photos were also made. Image-converter camera pictures, showing the radiation from the stagnation region as well as the luminous wake pattern of an ablating model in flight, were obtained. In addition to the experimental phase of the research program, some theoretical studies were performed, primarily in the field of radar absorption. R.T.K.

N64-21162 Itek Corp., Palo Alto, Calif. Vidya Research and Development
ON THE USE OF IMPACT THEORY FOR SLENDER CONFIGURATIONS EXHIBITING FLOW SEPARATION
Alvin H. Sacks and Jack A. Burnell 31 Mar. 1963 38 p refs
(Contract Nonr-3103(00))
(Vidya-92; AD-406468)

A method is presented for analytically predicting the nonlinear variation of normal force with angle-of-attack for very slender wing–body combinations exhibiting flow separation. The method is based on the cross-flow drag concept and employs Newtonian impact theory in two dimensions to calculate the cross-flow drag coefficient. This theory shows good agreement with experiment for two-dimensional incompressible flow past bluff shapes. Furthermore, the analytical expression for the flat plate agrees exactly with the theoretical analysis of Bollay. Mathematical expressions are developed for the normal force on a conical slender wing–body combination with elliptical body of arbitrary eccentricity. Calculations are compared with experimental normal forces on wing–body combinations at supersonic speeds, and on delta wings at subsonic speeds. The agreement appears to be very good over a wide range of angle-of-attack. For the sharp-edged delta wing, agreement with experiments is better than for other theories. Author

N64-21170 General Motors Corp., Santa Barbara, Calif. Defense Research Labs.
A BROAD SURVEY OF FREE-FLIGHT RANGE MEASUREMENTS FROM THE FLOW ABOUT SPHERES AND CONES
R. I. Primich and M. Steinberg Sep. 1963 45 p refs
(Contract DA-04-495-ORD-3567(Z); ARPA Order 347-63)
(GM-TR-63-224; AD-427050)

Free-flight measurements of the flow about both nonablating and ablating spheres, sphere-capped cylinders, and cones are reported. Included are radiometer measurements in the 0.2 to 5.5μ band, image converter and schlieren photographs, microwave measurements of wake ionization, head-on radar cross-section measurements, backscatter radar cross-section measurements of turbulent trails, and measurements of precursor ionization. Radiation results for nonablating spheres, the effect of contaminants, and a comparison between sphere and cone results are presented. The status of the head-on radar results that include anomalous absorption was discussed. Precursor ionization ahead of nonablating spheres was identified and attributed to photoionization. Comparative results of both schlieren and radar systems, which involve transition from laminar to turbulent flow and scattering from turbulent wakes, are outlined. For cones, conditions cover velocities up to 22,000 ft/sec and pressures up to 150 mm Hg, whereas for spheres, velocities range up to 24,000 ft/sec and pressures up to 300 mm Hg. Author

N64-21271* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
NUMERICAL SOLUTIONS OF FREE-MOLECULE FLOW IN CONVERGING AND DIVERGING TUBES AND SLOTS
Edward A. Richley and Thaine W. Reynolds Washington, NASA, Jun. 1964 47 p refs
(NASA-TN-D-2330) OTS: $1.25

The integral equations governing flux distributions for free-molecule flow through converging or diverging tubes and slots are developed under assumptions of uniform entering flux and diffuse particle reflection from the walls. The equations are solved on an IBM-7094 computer by applying an iterative method of solution. Specific cases studied in the analysis are tube length to radius ratios of 1/2, 1, 2, 4, 8, and 16; slot length to width ratios of 1/4, 1/2, 1, 2, 4, and 8; and for each ratio, up to 14 variations of wall half-angle ranging from 75° to −60°. Wall and exit-aperture flux distributions and total and direct transmission probabilities are presented as functions of these parameters. Transmission probabilities for a wall half-angle of zero are compared with results of other investigations and show excellent agreement. Results are presented in tabular and graphic form, and reasonably accurate results for parametric values within the specified ranges may be determined by interpolation. Author

N64-21390 Arbeits- und Forschungsgemeinschaft Graf Zeppelin, Stuttgart (W. Germany)
MODERN FUSELAGE ANALYSIS
J. H. Argyris and Ulrich Hütter (Tech. Hochschule Stuttgart) May 1962 68 p refs Presented at the 57th Aviation Meeting on Autom., Statist., and Dyn. Methods for Calculations of Flying Structures, Stuttgart, 8 May 1962 Discussion in GERMAN

An explanation of the fuselage theory is presented along with its relation to aircraft structures and the structure-stress matrix. The notation of stress matrix does not give any particular insight into the theory of structure. The real tests of the practicality of a theory lie in the proposed mechanisms leading into the computation of the matrix notations. In this case, the matrix gives only the self-equilibrating stress systems and the splitting of the redundancies into distinct groups, which allows for computation of complex structures, but does not give an understanding of the theories involved. A.L.B.

N64-21417 Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.
WIND-TUNNEL INVESTIGATION OF TURBULENT BOUNDARY LAYERS ON AXIALLY SYMMETRIC BODIES AT SUPERSONIC SPEEDS
Darwin W. Clutter and Kalle Kaups 6 Feb. 1964 270 p refs
(Contract NOw-61-0404-T)
(LB-31425; AD-435111)

An experimental investigation was conducted to determine the characteristics of supersonic turbulent boundary layers in regions of large pressure gradients, both favorable and adverse, and with and without heat transfer. Details of the velocity, temperature, and static-pressure profiles were measured at several stations on three bodies of revolution at Mach numbers from 1.61 to 4.50. One of the bodies was equipped with an internal cooling system so that profile data could be obtained for a cooled-wall condition as well as for the adiabatic-wall condition. Profile data are presented in both graphical and tabular forms. Integrated boundary-layer thicknesses—displacement, momentum, and energy—are presented. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N64-21075 Lockheed-California Co., Burbank
WIND-TUNNEL INVESTIGATION OF SINGLE AND TANDEM LOW-ASPECT-RATIO WINGS IN GROUND EFFECT Technical Report [6 Feb.-26 Mar. 1963]
John R. Brown Ft. Eustis, Va., Army Transportation Res. Command, Mar. 1964 105 p refs
(Contract DA-44-177-AMC-822(T))
(Rept. 16906; TRECOM-TR-63-63; AD-600498)

The effects of end-plate and camber changes on the aerodynamic characteristics of five basic wings in ground effect were investigated by the image technique, and the effect of gap-chord and aspect ratio was investigated on tandem-wing combinations over a ground board. For a given wing trailing-edge structural clearance height, end plates show considerable improvement in L/D. Improved L/D is also noted for small down-flap deflection, contoured end plates, wedge-bottom end plates, thin wing, and high aspect ratio. Static stability improves as the ground is approached and is particularly evident for the tandem-wing combinations. Limited data were obtained in roll and yaw. Author

N64-21076 Kaman Aircraft Corp., Bloomfield, Conn.
COMPILATION AND ANALYSIS OF TEST DATA ON FIBER-GLASS-REINFORCED PLASTICS Technical Report, 15 Jun.-15 Nov. 1963
Roland C. Anderson Fort Eustis, Va., Army Transportation Res. Command, Mar. 1964 236 p
(Contract DA-44-177-AMC-90(T))
(R-479; TRECOM-TR-64-9; AD-600514)

This report is a compilation and analysis of significant test data obtained in the evaluation of an all-glass rotor blade. Included are the associated areas of the development of glass-fiber control tubing, the use of glass reinforcement for the "Roto-prop" (rotor-propeller) on a V/STOL aircraft, the elastic-hinge study suggesting a maintenance-free tail rotor, and the effects of weathering upon glass-blade properties and structure. Author

N64-21103 David Taylor Model Basin, Washington, D.C. Hydromechanics Lab.
SUPERCAVITATING AND VENTILATED PERFORMANCE OF THREE HYDROFOIL SECTIONS
G. F. Dobay and N. L. Ficken Jan. 1964 105 p refs
(DTMB-1828; AD-437158)

Two-term, five-term, and flat-faced hydrofoils with AR = 3, rectangular planform, have been tested to determine their supercavitating and ventilated performance. It has been found that the five-term section provides the highest lift-drag ratio for the same lift coefficient. The theoretical prediction agrees well with experimental data at high angles-of-attack. Means are suggested to hasten the development of leading-edge cavitation at low angles-of-attack and to overcome the oscillating nature of the lift and drag forces in the transition region (between fully wetted and fully cavitating conditions). Author

N64-21152 Itek Corp., Palo Alto, Calif. Vidya Div.
A THEORY FOR THE LOW-SPEED AERODYNAMICS OF STRAIGHT AND SWEPT WINGS WITH FLOW SEPARATION
Alvin H. Sacks, Jack N. Nielsen, and Frederick K. Goodwin 31 Mar. 1963 156 p refs
(Contract Nonr-3103(00))
(Vidya-91; supersedes Vidya-38; AD-460705)

A mathematical theory is developed for the low-speed aerodynamics of rectangular wings with side-edge separation. The theory is then extended to wings with sweptback leading edges and straight trailing edges by representing the actual wing as a system of elementary rectangular wings of varying aspect ratio. The report consists of seven chapters dealing with theory, calculations, experiments, and discussion. A.W.

N64-21205 Pennsylvania State U., University Park
AERODYNAMICS OF THE FLEX-WING
Benjamin Dolbin and Melvin Caldwell [1963] 18 p refs

A theoretical analysis and wind tunnel tests have been made to determine the aerodynamic characteristics of the flex-wing. The effects of varying apex angle, bellowing ratio, and angle-of-attack were investigated. In this study Jones' theory for low-aspect-ratio pointed wings is extended to account for the curvature of the skin. The theoretical and experimental results show that the lift curve slope increases with aspect ratio and decreases with increasing bellowing ratio. Author

N64-21230 Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (W. Germany) Institut für Flugmechanik
A METHOD FOR COMPUTING THE NONSTATIONARY FORCES ON A WING OF FINITE SPAN IN A NONCOMPRESSIBLE FLOW [Eine Methode Zur Berechnung Der Instationaren Krafte An Flugeln Endlicher Spannweite in Inkompressibler Stromung]
A. Von Baranoff 21 Feb. 1964 47 p refs In GERMAN
(DFL-236)

An integral-equation method is developed for investigating the problem of a finite wing in an incompressible flow, which depends upon the velocity potential. The method was developed in order to avoid using the usually utilized classical method. A detailed investigation was undertaken for two borderline cases (very great and very low aspect ratio) of a rectangular wing. A general case is worked out, using approximations, and numerical results that were obtained are discussed. P.V.E.

N64-21262* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AIRFOIL CHARACTERISTICS IN A NONEQUILIBRIUM AMBIENT STREAM BASED ON LINEARIZED THEORY
James J. Der Washington, NASA, Jun. 1964 19 p refs
(NASA-TN-R-201) OTS: $0.50

The aerodynamic characteristics of a lifting body in a nonequilibrium stream are studied for the case of a nonequilibrium oncoming stream past a thin airfoil at a small angle-of-attack. Analytical solutions are obtained by the use of nonequilibrium linearized theory. Results show that when the relaxation length on the windward side of the airfoil is not appreciably different from that on the leeward side, a nonequilibrium ambient condition will normally induce a higher pressure and lower drag, but will not affect the lift, pitching moment, and the center of pressure. The local nonequilibrium condition behind the leading-edge shock, on the other hand, will affect all of the aerodynamic characteristics. When the relaxation length on the windward side is significantly different from that on the leeward side, on the other hand, the nonequilibrium ambient condition will also affect the lift, pitching moment, and the center of pressure. The higher suction on the leeward side gives higher lift and larger pitching moment because the condition on the leeward side is closer to frozen. Author

N64-21274* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOME EFFECTS OF PLANFORM MODIFICATION ON THE SKIN FRICTION DRAG
Edward J. Hopkins Repr. from AIAA J., v. 2, no. 2, [1964] p 413–414
(NASA-RP-170)

In the rapid estimation of the skin-friction drag of aircraft wing and control surfaces, when the calculation of the Reynolds number is based on a simple average geometric chord of the surface, the approximate solution can differ significantly from the more exact solution involving a spanwise integration of the skin friction. Shown in figures are ratios of the average skin-friction coefficient for cranked wings to rectangular wings, as well as for tapered wings to rectangular wings. Results indicate that, for wings having straight leading edges and small taper ratios, the skin friction cannot be obtained accurately from a Reynolds number based on its average chord. I.A.A.

N64-21319 Vehicle Research Corp., Pasadena, Calif.
A LIFTING SURFACE THEORY FOR WINGS AT HIGH ANGLES OF ATTACK EXTENDING THROUGH MULTIPLE JETS
E. Cumberbatch 26 Jul. 1963 52 p refs
(Contract Nonr-2388(00))
(AD-423274)

A lifting surface theory has been developed for wings located at arbitrary heights and high angles-of-attack (up to the inception of flow separation) in a stream containing an arbitrary number of multiple jets (propeller slipstreams). The present theory was developed by first analyzing the simpler single jet case and then extending the analysis to encompass multiple jets. Thus, the analysis is systematically presented in the following order: (1) wing at an arbitrary height in a single jet; (2) wing at a high angle-of-attack in a single jet; and (3) wing at arbitrary height and high angle-of-attack extending through multiple jets. This generalized theory encompasses a broad spectrum of V/STOL aircraft. The prediction of wing–slipstream interactions afforded by the present analysis permits optimization of such V/STOL aircraft. Author

N64-21357 Hydronautics, Inc., Laurel, Md.
EXPERIMENTAL INVESTIGATION OF THE 5-INCH CHORD MODEL OF THE BUSHIPS PARENT SUPERCAVITATING HYDROFOIL
J. O. Scherer and J. Auslaender Mar. 1964 61 p refs
(Contract NObs-88164)
(TR-343-1; AD-600882)

Results of lift and drag measurements performed on a 5-in. chord model of the BuShips parent hydrofoil are presented and are compared with theoretical predictions. The tests were conducted in a high-speed, variable pressure, free surface, circulating water channel. They cover angles-of-attack ranging from 3° to 15°, vapor cavitation numbers from 0.06 to 2.34, depths of submergence of 1/2 and 1 chord, and velocities from 30 to 52 fps. At vapor cavitation numbers that are low enough so as to approach prototype values, the ventilation hysteresis is eliminated. Results are presented in the form of tables and graphs of lift and drag coefficients for variations of angle-of-attack and vapor cavitation numbers. Excellent agreement is found between theory and experiment. The problems of ventilation inception are also discussed. Author

N64-21453 Naval Ordnance Lab., White Oak, Md.
VERY LOW ASPECT RATIO WINGS IN HYPERSONIC FLOW Aerodynamic Research Report 214
William D. Piper Apr. 1964 22 p refs
(NOLTR-63-239; AD-431923)

An experimental investigation was conducted to determine the effectiveness of wings with very low aspect ratios in hypersonic flow and to determine the accuracy with which the normal force coefficient of such wings can be calculated. The configuration under consideration consisted of an 8-caliber long body of revolution with a low drag nose and four different sets of flat, rectangular wings varying in aspect ratio from 0.05 to 0.30. Wind-tunnel tests were conducted at a Mach number of 8 in a hypersonic tunnel and at Mach numbers of 3, 4, and 5 in a supersonic tunnel. Theoretical calculations of the wing normal force coefficients were made for the same configurations. The agreement between the theoretical calculations and the experimental results was generally good. Author

04 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc., and specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; safety devices; and stability and control. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

N64-21077 Frost Engineering Development Corp., Denver, Colo.
PRELIMINARY STUDIES OF THE APPLICATION OF PERIPHERAL FANS TO GROUND EFFECT MACHINES Final Report
P. R. Payne Ft. Eustiss Va., Army Transportation Res. Command, Apr. 1964 304 p refs
(Contract DA-44-177-AMC-5(T))
(FROST Rept. 142-18; TRECOM-TR-64-10; AD-600513)

Performance of existing annular jet air cushion vehicles (ACV) is limited by the substantial loss in efficiency between the fan and the nozzle. Because of the performance and design data available, axial flow fans were used on most early ACV in spite of the inefficiency of the axial fan in high-payload to gross-weight applications. The peripheral fan showed promise of correcting these two major shortcomings of current vehicles. A study was initiated to investigate the performance of several types of transverse flow fans to determine if any were suitable for an ACV lift system. Experimental investigation demonstrated that a flexible blade peripheral fan not only provided a relatively constant efficiency throughout its operating range but also promised increases in system efficiency of from 30 to 40 percent. Author

N64-21106 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
DESIGN OF LINEAR FLIGHT CONTROL SYSTEMS USING OPTIMAL CONTROL THEORY
E. G. Rynaski, P. A. Reynolds, and W. H. Shed Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Apr. 1964 138 p refs
(Contract AF 33(657)-7498)
(CAL-IH-1648-F-1; ASD-TDR-63-376; AD-600694)

This report describes a study of the application of optimal control techniques based on a generalized quadratic performance index to the primary control system design of an X-15-type aircraft and a large flexible booster. The following aspects of the application of optimal theory were studied: (1) the use of mathematical models to obtain desirable transient characteristics; (2) recognizing feedback configurations; (3) comparison between optimal and conventional design techniques; (4) relationships between the weighting factors of the performance index and the dynamics of the optimal system; and (5) using an IBM-700 program to obtain optimal solutions of the control problems. Author

N64-21279* National Aeronautics and Space Administration, Washington, D.C.
MATERIALS FOR WINGS AND FUSELAGE
Richard H. Raring Repr. from Materials Research and Standards, v. 3, no. 10, 1963 p 810–814 refs
(NASA-RP-183)

This is a brief review of the tentative conclusions of a sheet-material program for the study of steel, titanium, and superalloys for use in the construction of the Mach-3 SST. Screening studies are reviewed that are intended to provide more complete data on those alloys than were believed applicable, and the material rating parameters for the SST are tabulated and defined. Fracture-toughness tests were carried out to study several important variables, such as temperature, crack length, rate of crack growth, and gage. Also considered are the results of fatigue, creep, and stress corrosion tests. The most promising metals are AM350, AM355, and PH 14-8Mo steels; Ti-8Al-1Mo-1V and Ti-6Al-4V titanium alloys; and René 41, Waspalloy, and Inco 718 superalloys. I.A.A.

N64-21369 Hydronautics, Inc., Laurel, Md.
THE STATIC PERFORMANCE OF AN ASPECT RATIO 2/3 GROUND EFFECT MACHINE
Vincent R. Pfisterer Jan. 1964 78 p refs
(Contract Nonr-3189(00))
(TR-011-5; AD-600567)

The results of an experimental investigation of the static performance of an aspect ratio 2/3 peripheral jet ground-effect-machine model are presented and compared with available theory. The investigation included measurements of lift, pitching moment, base pressure, and plenum chamber pressure for the model with various nozzle thicknesses and base recess depths and for a variety of model heights and pitch angles. Results reported include the lifting performance and the static pitch stability of the model. Observations of the flow beneath the model were also made. Author

N64-21430* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC RESPONSE OF AIRPLANES TO ATMOSPHERIC TURBULENCE INCLUDING FLIGHT DATA ON INPUT AND RESPONSE
John C. Houbolt, Roy Steiner, and Kermit G. Pratt Washington, NASA, Jun. 1964 119 p refs
(NASA-TR-R-199) OTS: $2.50

A coordinated account of flight measurements of random atmospheric turbulence input, of calculated and experimentally determined airplane transfer functions, and of analytical procedures for determining output or airplane response is given based on the concepts of power spectral techniques. Atmospheric turbulence results for several meteorological conditions and altitudes (including new information from thunderstorms) are described, and consideration is given to the numerical values of the root-mean-square gust velocities and the turbulence scale parameter. Transfer functions obtained both by calculation and as deduced from flight tests are compared for rigid and flexible airplanes at subsonic speeds and for a rigid airplane at supersonic speeds. Some of the implications of power spectral techniques for load prediction and for design are discussed. Author

N64-21473 Vehicle Research Corp., Pasadena, Calif.
VORTEX RECIRCULATION LIFT FOR GROUND EFFECT MACHINES
T. Fujita, W. Bettes, and G. Wiederkehr 31 Dec. 1963 78 p refs
(Contract Nonr-3802(00))
(VRC-17; AD-433785)

A systematic experimental development of a vortex recirculation lift system for use on Ground Effect Machines (GEM) has uncovered a practical configuration that promises to eventually fulfill a large portion of the high potential predicted by theory. Ideally, the only power expenditure required to seal the high base pressure beneath a GEM is that of overcoming duct friction losses encountered by the recirculating air. The vortex recirculation system involves minimum ducting and hence is optimum. Although the present exploratory test results reflect the early development status, it is clearly demonstrated that (1) the deformed vortex flow pattern can be generated and sustained; (2) the pressure developed by the small test arrangement exceeds base pressures currently employed on peripheral jet GEMs; (3) the hovering power requirements of the extremely nonoptimum test unit are of the order of conventional peripheral jet GEMs indicating that a refined vortex recirculation system will greatly surpass current GEM lift systems; and (4) an inherently stable configuration might be evolved, since powerful stabilizing moments were obtained by simple variations in geometry. Author

05 ASTRONOMY AND ASTROPHYSICS

Includes celestial mechanics; and radioastronomy. *For related information see*: 12 Geophysics, and 29 Space Sciences.

N64-20819 Joint Publications Research Service, Washington, D.C.
PROBLEMS RELATING TO EQUALIZATION OF THE USSR ASTRONOMIC-GEODETIC NETWORK REVIEWED
O. V. Chernevskiy 25 May 1964 37 p refs Trans. into ENGLISH from Tr. Tsentral. Nauchn.-Issledovatel. Inst. Geodezii, Aeros'yemki i Kartografii (Moscow), no. 154, 1963 p 125–248
(JPRS-24729; OTS-64-31314) OTS: $1.00

The following problems concerning the revision of the astronomic latitudes, longitudes, and azimuths determined at the triangulation station are reviewed: (1) the star position system, (2) latitude observations, (3) longitude determinations, (4) determination of the astronomical azimuth, (5) short period nutation, (6) the introduction of corrections for the wandering of the pole in the latitudes, longitudes, and azimuths and in the reference time, and (7) standard time signals. R.T.K.

N64-20825* General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science
ZIRCONIUM ABUNDANCES IN METEORITES AND IMPLICATIONS TO NUCLEOSYNTHESIS
R. A. Schmitt, E. Bingham, and A. A. Chodos (Calif. Inst. of Tech.) 6 May 1964 38 p refs Submitted for Publication (Contract NASw-843)
(NASA CR-56189; FA-5164) OTS: $3.60 ph

The atomic abundance of Zr was established at 16 ± 5 Zr atoms/10^6 Si atoms in 17 ordinary chondrites, which agrees well with Aller's (1962) solar value of 14 Zr atoms/10^6 Si atoms. Apparently, fractionation of Zr occurred within the chondritic family, since 22 ± 3 Zr atoms/10^6 Si atoms were observed in 7 Type II and Type III carbonaceous chondrites. Zr was enriched in 4 Ca-rich achondrites by a factor of 5, which is consistent with other trace-element enrichments. Zr may be depleted in Ca-poor achondrites and pallasitic olivines. The low Zr abundance in chondrites, coupled with Rb, Sr, Y, and Mo chondritic abundances, indicates ~50% enhancement of the odd-A mass distribution at A = 89 due to the 50-neutron-shell closure. Abundance values of Zr and other nearby elements indicate Fe^{56} seed nuclei were exposed to different neutron fluxes. The atomic ratio Zr/Hf of 100 in meteorites compared with 106 in the terrestrial crust indicated no serious fractionation between these two very similar chemical elements. Author

N64-20886* New Mexico State U., University Park Research Center
PHOTOGRAPHIC OBSERVATIONS OF MARS AT NEW MEXICO STATE UNIVERSITY IN 1960–61
J. C. Robinson Repr. from Icarus, v. 2, no. 5–6, Dec. 1963 p 403–410 refs
(Grant NsG-142-61; Contract AF 19(604)-5570)

Routine three-color photography of Mars during the 1960–61 approach revealed the presence of a number of canals at this season, as well as the continued existence of the large dark area near the Thoth. Blue clearings were asymmetrically distributed about opposition, although the strongest degree of clearing apparently occurred at opposition. Blue cloud activity reached a maximum concurrently with the maximum extent of the polar haze caps in blue and ultraviolet, shortly after Martian vernal equinox. A persistent blue cloud streak paralleling the Gigas canal was found to rotate with the surface. Author

N64-21034 RAND Corp., Santa Monica, Calif.
THE DISTRIBUTION OF GASES IN THE PROTO-PLANETARY NEBULA
J. R. Jokipii May 1964 22 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3977-PR; AD-600023)

It is demonstrated that the distribution of elements in the solar system may be connected with solar magnetic fields. Relative diffusion of neutral particles and ions in a magnetic field ambipolar diffusion separates elements of different ionization potential. A simple model of the origin of the solar system, which takes account of ambipolar diffusion, successfully predicts relative terrestrial abundances of the noble gases Ne, A, Kr, and Xe. Author

N64-21126 Joint Publications Research Service, Washington, D.C.
PROBLEMS OF COSMOGONY, VOLUME ONE [1952]
25 May 1964 280 p refs Transl. into ENGLISH of Vopr. Kosmogonii, Akad. Nauk SSSR (Moscow), v. 1, 1952 p 1–285
(JPRS-24735; OTS-64-31319) OTS: $4.00

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N64-21127 Joint Publications Research Service, Washington, D.C.
ADVANCES AND PROBLEMS OF SOVIET COSMOGONY
Foreword

In its Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 1–10 (See N64-21126 14-05) OTS: $4.00

Advances and problems of Soviet cosmogony are reviewed. Some proofs exist for the newness of a number of stars and the systems that they form; stars are being formed at the present time. There has been progress in the theory of the internal structure of stars. For a large class of stars, the sources of energy in the form of nuclear reactions were determined. Data were obtained on the relative quantity of gas and dust in the interplanetary medium, the chemical composition of its gas, and its temperature in different regions—near stars and far stars. The discovery of an atmosphere on a satellite of Saturn and certain evidence of an atmosphere on the moon were established. The primary deep process in the earth is the redistribution of matter (differentiation), for the most part in accordance with density. Problems include: (1) investigation of the age of individual parts of the earth, its slow vertical movements, and investigations of magnetic phenomena; (2) the determination of the age of meteorites; (3) the development of the theory of evolutions of the sun and the influence of this evolution on the development of the planetary system; and (4) the evaluation of the age of stars of various types. I.v.L.

N64-21128 Joint Publications Research Service, Washington, D.C.

ON THE PROBLEM OF THE DENSITY AND COMPRESSIBILITY OF THE EARTH'S MANTLE

V. A. Magnitskiy *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 11–30 refs (See N64-21126 14-05) OTS: $4.00

The problem of the density and modulus of compression of the earth's mantle is considered according to the theory of solids. Assumptions concerning the composition of the earth's mantle are expressed. A method is proposed for constructing a working hypothesis explaining the process of the origin of the continental (sialic) part of the earth's crust and the course of its subsequent development. Author

N64-21129 Joint Publications Research Service, Washington, D.C.

ON THE ORIGIN OF THE SOLAR SYSTEM

V. A. Krat *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 31–88 refs (See N64-21126 14-05) OTS: $4.00

A hypothesis for the formation of the solar system is discussed. The formation of the planetary system is a part of the general process of star formation. The sun and the planets, similar to close binary and multiple stars, were formed from one cloud of prestellar bodies. As a result of the fragmentation of prestellar bodies in collisions around the central core, which later became the sun, a flat gas-dust nebula was formed, in which the prestellar bodies that had survived were included, and which served later as nuclei for the condensation of matter. Mercury and Venus were formed in a zone where the greater part of the Sun was vaporizing and was scattered in interstellar space. The outer crusts of the Earth, the Moon, Mars, and certain minor planets were formed from gases discharged by the Sun at the last stage of discharge, when radioactive elements were thrown out from the deep layers of the Sun. The major planets, Jupiter, Saturn, Uranus, and Neptune, are gaseous celestial bodies. The process of the combination of the condensations into planets at the boundary of the solar system, beyond the orbit of Neptune, is not finished. A broad belt of minor planets, of which Pluto is the largest, must exist beyond this orbit. In this zone comets are formed, probably as a result of the collisions of the minor planets. I.v.L.

N64-21130 Joint Publications Research Service, Washington, D.C.

THE NATURE AND POSSIBLE ORIGIN OF THE METEORITES, ZODIACAL LIGHT, AND THE ASTEROIDS

F. G. Fesenkov *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 89–127 refs (See N64-21126 14-05) OTS: $4.00

The nature and possible origin of meteorites, zodiacal light, and asteroids are reviewed. It is believed that initially stony meteorites were formed in a drop-liquid medium, obtained from planets subjected to decay. The finest droplets, in cooling off, formed chondrules and combined with the finest dust, forming the intermediate matter in modern chondrites. Iron meteorites have the same origin and were consequently formed from iron chondrules. Their modern structure developed later as the result of multiple recrystallization as a consequence of numerous approaches to the sun with a more or less specific heating. Zodiacal light is caused by the scattering of sunlight by dust particles consisting of fine fragments and sometimes comparatively large ones. This dust is formed by collisions between meteors and asteroids. These dust particles revolve around the sun primarily in the plane of the ecliptic. Asteroids are believed to be formed by the explosion of an initial planet. The origin of individual asteroidal families may be due to supplementary fragmentation of asteroids as a result of their mutual collisions. I.v.L.

N64-21131 Joint Publications Research Service, Washington, D.C.

ON THE EVOLUTION OF UNSTABLE STARS

B. A. Vorontsov-Vel'yaminov *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 128–140 refs (See N64-21126 14-05) OTS: $4.00

The author's interpretation of the white to blue sequence of stars is given as follows: Within a class of novae, the novae evolve toward a decrease in their luminosity, between flareups, because of the directly observed losses of mass, and toward increasing the amplitudes of flareups with an increase in the intervals of time between them. The problem of the possibility of the combination of two evolutionary links—Wolf–Rayet stars to novae and novae to white dwarfs—is discussed. This combination encounters a well-known difficulty in the frequent presence of satellites for Wolf–Rayet stars and in the lack of knowledge concerning satellites of the nearest novae, which are not recurrent novae. However, it is indicated that concepts of the origin of Wolf–Rayet stars and the gradual transformation of recurrent novae into white or blue dwarfs may be preserved. These concepts are confirmed by the theory of dense dwarf stars. I.v.L.

N64-21132 Joint Publications Research Service, Washington, D.C.

ON THE EVOLUTION OF UNSTABLE STARS: AN ANSWER TO THE COMMUNICATION OF B. A. VORONTSOV-VEL' YAMINOV

E. R. Mustel' *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 141–146 refs (See N64-21126 14-05) OTS: $4.00

Criticisms of the present author's views on the evolution of unstable stars are refuted. Discussed in particular are opinions concerning: (1) the evolutional nature of all white-blue sequences—from O-stars to white dwarfs; (2) the transmutation of novae into blue and white dwarfs; (3) the intermittent evolution of novae with their gradual transformation into white dwarfs; (4) the last link of the white-blue sequence chain; (5) the masses of novae; and (6) the mass of the shell ejected by NAql 1918. P.V.E.

N64-21133 Joint Publications Research Service, Washington, D.C.
ON THE PROBLEM OF THE KINEMATICS OF THE METAGALAXY
K. F. Ogorodnikov *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 147–188 refs (See N64-21126 14-05) OTS: $4.00

An analysis of the radial velocities of the galaxies indicated the following: (1) The application of the kinematics of centroids to the metagalaxy indicated that this galaxy is far from being located in the state of isentropic expansion usually ascribed to it. (2) The direction to the center of the metagalaxy may be determined under the assumption that the plane-parallel motion of the galaxies is composed of expansion and rotation. (3) The sequence of the relative velocities of the galaxies within the metagalaxy must be of precisely the same order observed. (4) The proper motions of the galaxies must contain a systematic term of the order of $2\pi \cdot 206\ 265 \cdot 10^{-11} \approx 10^{-5}$ sec in year when matching the weak stars to extragalactic nebulae. (5) Statistical mechanics established a cosmological generalization of Kepler's third law. I.v.L.

N64-21134 Joint Publications Research Service, Washington, D.C.
ON THE PROBLEM OF STELLAR ASSOCIATIONS
P. N. Kholopov *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 189–227 refs (See N64-21126 14-05) OTS: $4.00

The discovery of stellar associations, such as unstable groupings of giant hot stars, star chains, and groupings of irregular variable stars of the T Tauri type, introduced the criterion of dynamic instability, making it possible to judge the age of these stellar groupings. Stars are presently originating and knowledge is accumulating as to where and how they originate. In addition, Ambartsumyan indicated the significance of the nature of the structure observed in certain star clusters. Also, critical remarks by B. A. Vorontsov-Velyaminov, directed toward refuting the idea of associations, are discussed. I.v.L.

N64-21135 Joint Publications Research Service, Washington, D.C.
A NEW DETERMINATION OF THE MASS OF MERCURY
G. A. Chebotarev *In its* Probl. of Cosmogony, Vol. 1 [1952] 25 May 1964 p 228–235 (See N64-21126 14-05) OTS: $4.00

The corrected value for the mass of Mercury, according to E. Rabe who used the motion of the minor planet Eros in his determination, is $1:m_1 = 6{,}120{,}000 \pm 43{,}000$. However, only the first significant figure was reliably determined. Therefore, the problem of further determinations of the mass of Mercury, as before, remains an acute question of theoretical astronomy. Also, various methods for determining planetary mass are discussed. I.v.L.

N64-21158 ITT Federal Labs., San Fernando, Calif.
STELLAR IRRADIANCE MEASUREMENTS Final Report
Freeman F. Hall, Jr. Jan. 1963 55 p refs Prepared for Aerospace Corp., El Segundo, Calif.
(Contract AF 04(695)-169)
(AD-404717)

The results of a scan of the night sky in three spectral regions of the infrared, 1.3μ to 3.0μ, 3.0μ to 4.0μ, and 8.0μ to 13.0μ, are presented. A 50.8-cm aperture radiometer with instantaneous field-of-view 1/4° × 1/4° and a nodding Newtonian secondary mirror were used to obtain the results over a 6-week observation period in which 18% of the sky was scanned in the near infrared region. Several bright infrared sources were detected that were expected on the basis of extrapolation of their visual properties and assumed temperatures; such extrapolation of the supposed blackbody properties of stars to predict infrared magnitudes becomes progressively less reliable for the cooler stars and may fail by many magnitudes for the M7 and M8 classifications. A number of sources were detected that do not correlate with the position of any known stars brighter than eighth visual magnitude; some stars show much greater infrared brightness than expected, which may indicate the presence of cool companion stars. Scans in the intermediate and far infrared detected those few sources that were predicted to be bright in these spectral regions. This allowed setting the upper limit where troublesome backgrounds may be encountered on the order of 10^{-13} w/cm2. Author

N64-21389 Smithsonian Astrophysical Observatory, Cambridge, Mass.
THE MICROSCOPIC PROPERTIES OF METEORITES Contributions to Astrophysics, Volume 4, Number 6
Gustav Tschermak Washington, D.C., Smithsonian Institution 1964 110 p refs Transl. into ENGLISH of the book "Die Mikroskopische Beschaffenheit Der Meteoriten", Stuttgart, E. Schweizerbart'sche Verlagshandlung, 1885 Text in ENGLISH and GERMAN
GPO: $1.25

Concerned with mineralogy and petrography, this book is a summary of the author's extensive work with meteorites. Its value lies in its comprehensive collection of 101 photographs of the microstructures of stony meteorites. The author comments on the general characteristics of meteorites and gives detailed descriptions of specific meteorite types, such as: calcium-rich stones—poor in metallic iron; magnesium-rich stones—poor in metallic iron; magnesium-rich chondritic stones—with metallic iron; and the stony-iron meteorites. A.W.

06 AUXILIARY SYSTEMS

Includes fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters. *For primary propulsion systems see*: 27 Propulsion. *For related information see*: 08 Communications; 09 Electronics; 10 Facilities, Research and Support; 15 Instrumentation and Photography; and 22 Navigation and Guidance.

N64-20784* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
INTRODUCTORY REMARKS
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 5–20 ref (See N64-20783 14-01) OTS: $5.00

A review of the advances in studies of liquid metal, this paper details the various steps from the beginnings of a science of technology of liquid metals to what is termed "a new renaissance in the field...beginning in about 1959 and 1960"—this is the use of liquid metals in solving problems arising from nuclear fission, especially their use as fast breeder systems. Another development, since 1960, has been toward the application of liquid metals in the field of space engineering. The high-temperature aspect of liquid metals is a vital consideration. A plea is made for more basic studies of how systems work as well as for actual experimentation in the liquid-metal corrosion field. A.W.

N64-20814* Pennsylvania U., Philadelphia. Electrochemistry Lab.
STUDIES OF THE FUNDAMENTAL CHEMISTRY PROPERTIES AND BEHAVIOR OF FUEL CELLS First Semi-Annual Progress Report, 1 Oct. 1962-31 Mar. 1963
J. O'M. Bockris [1963] 59 p refs
(Grant NsG-325)
(NASA CR-56171) OTS: $5.60 ph

The status of the following areas is discussed: (1) the study of adsorption of organic substances in dilute solutions by an a.c. impedance-measurement technique; (2) the adsorption of organic compounds from aqueous solution on solid metal electrodes; (3) the utilization of ellipsometry for in situ electrochemical studies of film formation and growth on mirror electrodes immersed in aqueous solutions; (4) the electrooxidations of certain systems (ethylene–sulfuric acid, acetylene–sulfuric acid) on Pt, Ir, Rh, Au, and Pd; (5) the nature of current control in the very small pores of electrodes; and (6) an examination as to whether available facts on superequivalent adsorption can be made consistent with a noncovalent model. I.v.L.

N64-20887 California U., Berkeley. Lawrence Radiation Lab.
OPTIMUM PROPORTIONAL CONTROL OF A BLENDING PROCESS USING IMPRECISE FEEDBACK INFORMATION
Carl N. Taylor (M.S. Thesis) and Alan Foss 17 Feb. 1964 54 p refs
(Contract W-7405-ENG-48)
(UCRL-11295) OTS: $1.25

This experimental study verifies the applicability of Acrivos's analysis of linear processes to a randomly disturbed continuous liquid blender that blends water and a salt solution. The process is controlled by a simple proportional controller that was fed imprecise feedback information. Evaluation of process performance was based on the time-averaged value of the square of the concentration fluctuations of the blended stream. Calculation of the mean-square-concentration fluctuations by Acrivos's method shows the mean-square deviations were a function of loop gain, the relative magnitude of the measurement error, and the effluent concentration fluctuations at zero control, the relative-frequency content of the measurement error and the input disturbance signals, and natural damping-frequency characteristics of the blending process. The predictions of process performance calculated by this method were verified by the experimental results that show that the mean-square deviations cannot be reduced to zero, but rather a minimum value is obtained as the amount of control action is varied. This minimum resulted from the counteraction of the favorable effect of feedback of the concentration measurement and the undesirable effect of measurement error. Author

N64-20889* Thompson Ramo Wooldridge, Inc., Cleveland, Ohio
SUNFLOWER SOLAR COLLECTOR
Washington, NASA, May 1964 200 p refs
(Contract NAS5-462)
(NASA CR-46) OTS: $3.00

Based upon specified orbital missions and associated environments, a paraboloidal solar concentrator was designed. The design was such that deployment to the final geometric shape was accomplished from the Centaur vehicle nose cone volume. A full size 32.2-ft-diameter collector composed of 30 deployable segments was fabricated and assembled as a preprototype model for structural integrity investigations, and was successfully deployed in a simulated zero gravity environment. Also, environmental tests of launch vibration and orbital transfer vibration and acceleration were conducted with no major structural damage. Optical inspections of the paraboloid were performed to determine the effect of these environmental loadings upon the optical quality. Single sectors of the collector were fabricated and reflective-coated in a specially designed vacuum deposition facility, for optical and performance testing. Optical quality of these preprototype segments was measured and compared with results of calorimetric efficiency measurements using solar energy. A full collector solar performance test facility was designed and built for combinations of collector and collector-receiver testing and ultimately for full system testing. Author

N64-20900 Societe d'Études, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)
STUDY OF THE GENERAL PROPERTIES OF SOME MINERAL ION EXCHANGE MEMBRANES AS WELL AS THEIR POSSIBLE USE IN LOW TEMPERATURE FUEL CELLS Final Report, Jan. 1-Sep. 30, 1963
31 Oct. 1963 72 p refs
(Contract DA-91-591-EUC-2773)
(AD-433803)

It was concluded from the study that: (1) The principle of using ion exchange membranes made of mineral ion exchangers such as phosphates of Sn, Ti, and Nb is valid. (2) The techniques developed in the preliminary study (synthesis of exchangers, fabrication of membranes, fuel-cell arrangement) enabled the obtaining of fuel cells with power densities of more than 40 mw/cm^2 under approximately 0.4 to 0.5 v. (3) The cells were working for a number of hours under bad conditions (near short circuit—0.1 Ω load—that is under worst polarization conditions), and showed no deterioration. (4) Failures came from irregularities in membrane fabrication. (5) Further work should examine the possibility of reducing the polarization of the oxygen electrode. Author

N64-21041 Oak Ridge National Lab., Tenn.
A POTASSIUM-STEAM BINARY VAPOR CYCLE FOR NUCLEAR POWER PLANTS
W. R. Chambers, A. P. Fraas, and M. N. Ozisik May 1964 54 p refs
(Contract W-7405-ENG-26)
(ORNL-3584) OTS: $1.25

The basic factors limiting the efficiency of both conventional steam-power plants and mercury-vapor and steam binary-cycle plants are discussed relative to the potential of a potassium-vapor and steam cycle for nuclear-power plant applications. A conceptual design for one embodiment of the latter coupled to a molten-salt reactor is described. Its thermal efficiency was estimated to be 54%, and the associated calculations, including those for the size of the principal components, was appended. The quantities of material required for the heat exchangers and piping for both a coal-fired supercritical-pressure steam plant and a nuclear-powered potassium vapor and supercritical-steam plant were estimated along with the associated costs. The resulting cost and performance data indicated that the nuclear plant with a potassium-vapor and steam binary cycle could give both lower capital charges and a much higher overall efficiency than a coal-fired supercritical-pressure steam plant. Author

N64-21053 ITT Gilfillan, Inc., Los Angeles, Calif.
REGAL TEST PROGRAM SUPPORT Final Report, Mar. 1960-Jun. 1963
22 Apr. 1964 108 p refs
(Contract FAA/BRD-245)

The engineering results of the REGAL test evaluation program conducted by the FAA are presented. The basic objective of the program was to determine the feasibility of the REGAL

system, using an interferometer antenna, and to provide airborne derived elevation angle and range data capable of providing accurate guidance for landing aircraft. Comprehensive static and dynamic testing revealed that REGAL has an elevation accuracy of 0.03° for all angles 0.25° above the mean ground plane and that the range techniques present the ability to approach within ±50 ft or 1%, whichever is greater, of the actual range. The latter part of the program was used to determine how well REGAL actually performed in a landing system. Over 200 completely automatic landings were achieved using four different type aircraft, all equipped with different type landing computers and autopilots. Author

N64-21058 General Motors Corp., Indianapolis, Ind. Allison Div.

POTASSIUM-MERCURY AMALGAM BOILING HEAT TRANSFER, TWO-PHASE FLOW, AND PROPERTIES INVESTIGATION

Y. S. Tang, C. R. Smith, and P. T. Ross 16 Sep. 1963 21 p refs (Previously published as N63-15016 11-13)

(Rept. 3549)

Progress achieved toward the development of a thermally regenerative liquid-metal cell, with K–Hg amalgam as the anode and Hg as the cathode, includes: (1) The heat-flux density for the net boiling region of 44.5% K and 14.7% K test sections was determined as a function of wall superheat. Considerably higher wall superheat was required for the 14.7% K amalgam. (2) The heat-flux density for surface boiling of the 44.5% K amalgam as a function of wall superheat was determined. The local heat-flux densities were higher near the boiler entrance than near the net boiling region. (3) A comparison was made between the net boiling heat-transfer data for K amalgams and that for pure K and pure Hg. (4) Values of the void fraction and of the two-phase quality of 44.5% K and 14.7% K amalgams were derived. (5) A correlation of the void fraction with the velocity ratios was made for these two amalgams. (6) A vapor-liquid equilibrium diagram was established for the K amalgam systems (80%, 60%, and 47% K by mole fraction) at 760-mm Hg pressure. (7) An equation relating the mole composition of Hg liquid and vapor, temperature, and enthalpy of the components was developed by employing the method of Othmer, Ricciardi, and Thaker. (8) Results of diffusivity studies indicated that the diffusivity increased considerably with increasing K concentration. I.v.L.

N64-21059 Naval Research Lab., Washington, D.C. Chemistry Div.

THE SULFATE CYCLE FOR CARBON DIOXIDE REMOVAL AND OXYGEN GENERATION

A. L. Pitman and S. T. Gadomski 18 Feb. 1964 18 p refs (NRL-6033; AD-432971) OTS: $0.50

A laboratory-scale plant of the sodium sulfate cycle system for oxygen generation and carbon dioxide removal aboard nuclear-powered submarines was constructed and operated. Joint operation of the major components, each of which previously were separately evaluated in the laboratory, was successful. The diaphragms used in the electrolytic cell were expected to provide difficult problems, and although asbestos diaphragms were known from the start to have a limited usefulness under anodic conditions, they proved to be more troublesome than anticipated. Fortunately, a diaphragm research group was able to recommend a replacement material, and using microporous rubber diaphragms in miniature electrolytic cells, achieved several continuous runs of 125 days. With the diaphragm problem solved if microporous rubber were used, results obtained on the laboratory-size sulfate cycle system establish the feasibility of this system for nuclear-submarine service. Author

N64-21063 Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.

DESIGN OF HYDROGEN-OXYGEN CAPILLARY TYPE FUEL CELL First Quarterly Technical Progress Report, 1 Nov. 1963–31 Jan. 1964

J. C. Prestridge, comp. 15 Feb. 1964 43 p

(Contract AF 33(615)-1185)

(AD-432239)

Design, fabrication, and performance testing of a 50-watt static-orbit fuel cell is discussed. The fuel cell will consist of two hydrogen–oxygen fuel cells electrically connected in series. The electrolyte concentration in the cell will be controlled by a static moisture-removal system. The design can be separated into three basic systems—the reactant-control system, the moisture-removal system, and the thermal-control system. The reactant-control system consists of a pressure regulator, a pressure transducer, and a solenoid valve for each of the reactant gases. A relief valve and a pressure transducer are used in the moisture-removal system. During prelaunch and ascent, the thermal control is provided by four 25-watt, 28-volt heaters supplied by vehicle power. The orbital thermal control is established by four $0.28^{+.00}_{-.01}$ ohm heaters and an external load resistor. The fuel cell will supply electrical power to a 20-watt external load resistor continuously while in orbit. P.V.E.

N64-21154 Avco-Everett Research Lab., Everett, Mass.

ROTATING MACHINERY UTILIZING SUPERCONDUCTORS

Z. J. J. Stekly and H. H. Woodson (MIT) May 1964 42 p refs

(Contract DA-44-009-AMC-236(T))

(Avco-Everett Res. Rept. 181; AD-600662)

The electrical, mechanical, and thermal losses that will occur in superconducting rotating machines are defined and estimated. The requirements for maintaining the cryogenic environment are given in terms of refrigerant use and in terms of refrigeration. The results of a circuit analysis of an alternator are given to define the maximum performance in terms of circuit parameters. The results of an electromagnetic field analysis are used to relate circuit parameters to geometry and material properties. On the basis of these analyses some estimates are made of the specific mass of alternators with superconducting armatures and with ambient temperature armatures. A system is proposed for a 1,000 kva turboalternator having a specific mass of 1.85 lb/kw, including the gas turbine and the refrigerator. Author

N64-21237 Dynasciences Corp., Fort Washington, Pa.

A HIGH-PERFORMANCE ELECTROSTATIC DISCHARGER FOR HELICOPTERS Final Report, Dec. 1962–Jun. 1963

J. de la Cierva, L. Egea, D. B. Fraser, and A. A. Perlmutter Ft. Eustis, Va., Army Transportation Res. Command, Dec. 1963 97 p refs

(Contract DA-44-177-AMC-3(T))

(DCR-113; TRECOM-TR-63-43; AD-600451)

This report contains the results of a program concerned with the design, construction, and flight testing of a high-performance static electricity discharging system for helicopters. Flight test data showed that the discharging system kept the electrostatic energy of a CH-37 helicopter below 1 millijoule for natural charging currents of up to 50 μa. Data were also obtained on the radio interference characteristics of the system and on the performance of corona points located in the engine exhaust stream. Author

N64-21241 Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

A SATELLITE-BORNE XENON FLASH OPTICAL BEACON FOR USE ON THE PROPOSED MISSILE RANGE CALIBRATION SATELLITE. PART III: PROGRAM PLAN Final Report

F. T. Gronberg, R. I. Saunders, and C. Warner 23 Feb. 1964 15 p

(Contract AF 19(628)-2979)

(EG&G-B-2730; AFCRL-64-125(3); AD-438874)

A preliminary electronic and mechanical design, plus a set of definitive preliminary specifications for a xenon flash system, that can be carried aboard and meets all the needs of the proposed Range Calibration Satellite has been completed. This volume contains the future scope of work and the estimated costs and schedule for the final design, fabrication, and delivery of the Cal-Sat optical beacon. R.T.K.

N64-21252* Thompson Ramo Wooldridge, Inc., Cleveland, Ohio

DEVELOPMENT OF THE DUAL MEMBRANE FUEL CELL AND THE OSMOTIC STILL Final Report, 30 Jun. 1962–15 Dec. 1963

Washington, NASA, May 1964 227 p refs

(Contract NAS3-2551)

(NASA-CR-43) OTS: $3.50

Fuel cell components satisfactory for service in 6 N H_2SO_4 at temperatures up to 95° C were determined. Critical components selected included the Ionic 61-AZG cation membrane and niobium current collectors. Ultimately a 10-cell battery was constructed according to results obtained on five 5-cell batteries. The 10-cell battery performance was characterized by 7.8 v at 24 amp/ft^2 (a 15% increase over the design goal), a specific conductance of 360 mhos/ft^2/cell and a peak power density of 64 w/ft^2/cell. Increasing the operating temperature increased the performance. Electrolyte normality, N_e, gas flowrates, and small changes in pressure levels (5 to 15 psig) had no noticeable effect on performance. The liquid transport rate across the H_2 side membrane, however, was $\propto N_e^2$, and the transport across the O_2 side membrane was $\propto N_m^{-2}$, where N_m is membrane normality. A conservative 2-kw fuel cell battery was designed. In addition, a number of commercially available membranes were evaluated for use in an osmotic water separating still. Author

N64-21291 Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

A STUDY OF THE ADSORPTION MECHANISMS ON OXYGEN ELECTRODES Third Semi-Annual Report, 1 Jun.–31 Dec. 1963

Y. L. Sandler Ft. Monmouth, N.J., Army Electron. Res. and Develop. Lab., 10 Jan. 1964 55 p refs

(DA-36-039-AMC-00136(E); ARPA Order 226)

(AD-438942)

Further work on different types of isotopic exchange reactions of oxygen on silver near 200° and at 500° C is presented. Contrary to previous conclusions, the desorbing oxygen is in isotopic equilibrium. At least two types of oxygen chemisorption differing in binding energy and in their coordination with silver atoms contributed to the exchange, but only the weaker chemisorption is involved in the adsorption and desorption process at 200° C. The rate of desorption depends on the high-temperature pretreatment with oxygen, but the activation energy does not. Hydrogen pretreatment causes a change in the activation energy of the oxygen desorption. On oxidized palladium (PdO), two types of chemisorption were found, and evidence is presented for the existence of an endothermal adsorption. Preliminary experiments on the effect of different gas pretreatments on oxygen electrode characteristics were carried out in a cell operating at room temperature with 15% KOH as an electrolyte. Current-potential characteristics were studied with silver, gold, platinum, and some alloys or multiphase materials. Using a silver-magnesium alloy, a relatively high and stable open-circuit potential was obtained, and there was less polarization under current drain than with pure silver. Author

N64-21297 General Electric Co., Lynn, Mass.

MATERIALS OF CONSTRUCTION FOR HYDROCARBON-AIR FUEL CELLS WITH HOT CONCENTRATED PHOSPHORIC ACID ELECTROLYTE Interim Report No. 1

P. V. Popat and A. Kucher 1 Apr. 1964 31 p

(Contract DA-44-009-AMC-479(T); ARPA Order 247)

(AD-439400)

Of all the massive metals and alloys investigated to date, the following metals and alloys appear to have sufficient resistance to chemical corrosion in nonaerated phosphoric acid at 150° C (corrosion rate less than 1 mil per year): gold; platinum; an alloy containing 40% palladium, 30% silver, and 30% gold; certain alloys of palladium (high) with nickel or chromium; chlorimet-2, tantalum; alloys of tantalum with tungsten; molybdenum; tungsten–iridium (0.1%) alloy; and certain carbides. Certain varieties of carbons manufactured primarily for fuel cell applications appear resistant to phosphoric acid corrosion under chemical as well as electrochemical (up to one volt) environments. Of the various plastic materials investigated, Teflon (FEP), Teflon (TFE) glass-filled, Teflon (TFE), and Kynar show good stability and compatibility both in hot concentrated phosphoric acid and in the hydrocarbon fuel JP-4 at 150° C. Author

N64-21315 Mallory Battery Co., Tarrytown, N.Y.

TESTING AND EVALUATION OF PRIMARY ALKALINE CELLS AND BATTERIES Sixth Semi-Annual Report, 15 Mar.–31 Jul. 1963

Roger Goodman 31 Jul. 1963 43 p

(Contract DA-36-039-SC-78320)

(AD-439454)

The object of this study is the testing and evaluation of primary alkaline cells and batteries of the zinc–alkaline–mercuric oxide system over a wide range of discharge rate, temperature, and storage time. Initial discharge data for cell-type 650R at temperatures from 20° to 200° F, at 70° F, and with rates of discharge from 1 to 100 hours were completed. Monthly emf readings on nine cell types are presented. Delayed-discharge test results are presented for cell types 42R at 12 months, 502R at 18 months, 625R at 12 months, 650R at 1, 2, and 3 months, 1438R at 6 months, and 1450R at 12 months. R.T.K.

N64-21323 Columbian Carbon Co., Princeton, N.J. Technol. and Planning Dept.

CARBON BLACK FOR ORGANIC DEPOLARIZER BATTERIES Second Quarterly Progress Report, 1 Oct.–31 Dec. 1963

M. T. Johnston and J. E. Smith [1963] 31 p

(Contract DA-36-039-AMC-03239(E))

(AD-600250)

Carbon blacks from 20 statistically designed runs on the 14R furnace were evaluated in organic depolarized dry cells. Extensive data are also presented on physical and chemical characteristics of the experimental blacks. Initial service life of A-size cells discharged continuously through 16 2/3 ohms resistance to an end voltage of 0.9v ranged from about 22 to 27 hours. No single furnace variable studied was able to bring

about changes in the carbon blacks produced that significantly improved the performance of organic cells containing the various carbon blacks. However, two interactions were significant. Author

N64-21326 Radio Corp. of America, Harrison, N.J. Special Electronic Components Div.
THERMOELECTRIC POWER MODULES Final Report No. 4, 2 Jan.–31 Dec. 1963
Hans P. Van Heyst and Timothy M. Cunningham 31 Jan. 1964 130 p refs
(Contract DA-36-039-AMC-00110(E))
(AD-600365)

Silicon–germanium thermoelectric power modules were designed and developed. Modules operated satisfactorily under steady-state and thermal cycling conditions for several thousand hours. A thermoelectric power module was developed that can be used as a building block in the design of thermoelectric power generators. Considerations in terms of electrical, mechanical, and thermal design requirements indicated that an effective element length of 2.03 cm incorporated in a six-couple module could be used effectively in the building block design. The modules, when operated at a hot junction temperature of 840° C and at a cold junction temperature of 238° C, would deliver 4.2 w at 0.91 v for matched load conditions. A device efficiency of 6% was shown by analytical computations and by laboratory measurements. Author

N64-21345 Martin Co., Baltimore, Md. Nuclear Div.
RESEARCH AND DEVELOPMENT FOR BARIUM VAPOR-FILLED THERMIONIC ENERGY CONVERSION TECHNOLOGY Summary Report, Feb. 1962–Mar. 1964
A. J. Kennedy May 1964 140 p refs
(Contract AT(30-1)-2933)
(MND-2933-2) OTS: $2.50

Experimental data are given for plasma thermionic energy converters in which barium, rather than cesium, is used as the vapor material. Barium adsorption on refractory metal emitters, in the temperature range of 1800° to 2200° K, is such that current densities of 1 to 10 amp/cm^2 are obtained at vapor pressures of less than 0.1 mm Hg. Consequently, power losses due to collision in the interelectrode gap are quite small, and performance shows little dependence on interelectrode spacings, even for spacing as large as 0.020 in. to 0.050 in. Performance of the barium vapor-filled converter is also marked by an ability to use a high collector temperature; output power densities in the range of watt/cm^2 maximize at collector temperatures in excess of 1200° K. Author

N64-21358 Pratt and Whitney Aircraft, East Hartford, Conn.
LIQUID METAL-HEATED SPACE RADIATOR-MOUNTED THERMIONIC GENERATOR Third Quarterly Report, 1 Jan.–31 Mar. 1964
Franz C. Harter [1964] 29 p
(Contract AF 33(657)-11320)
(PWA-2337; AD-437926)

A program to demonstrate the use of thermionic generators when heated by liquid metal in the temperature range from 1,200° to 1,500° C is discussed, and initial test results and assembly techniques are presented. The basic converter consists of a tungsten–25% rhenium alloy emitter tube 0.050 in. thick and insulated from a nickel collector by two aluminum oxide seals. The collector is cooled by copper fins that are coated with thick, high-emissivity material. The electrode surfaces are finished to 20 rms, and the spacing is 0.008 inch. A beryllium oxide tube 0.015 in. thick insulates the emitter tube. The cesium reservoir is made of nickel and is thermally-isolated from and connected to the main body of the converter by a thin-walled tube. Electrical-resistance radial heaters are used to control the temperatures of the cesium reservoir and the collector. The emitter is heated by an electrical-resistance radiant, bifilar tungsten filament. At the design emitter temperature, 1,500° C, the power output recorded is 5.8 w/cm^2, and the efficiency is 9.7%. The testing uncovered a form of thermal instability that is due to the effects of electron heating of the collector. P.V.E.

N64-21420* Thompson Ramo Wooldridge, Inc., Cleveland, Ohio
60-INCH STRETCH-FORMED ALUMINUM SOLAR CONCENTRATOR
Washington, NASA, Jun. 1964 58 p refs
(Contract NAS1-3216)
(NASA-CR-47) OTS: $1.50

The objective of this contract has been to develop a solar concentrator made of aluminum, which will have performance sufficient for use in space power conversion systems. The design goal has been to achieve adequate surface quality for use in conversion systems with operating temperatures of 1,800° K as are encountered in thermionic-type devices. Such quality would also provide even higher performance in lower temperature applications, such as the Rankine and Brayton cycle engines. The aluminum construction is desirable because of its lower specific gravity (with a resulting lower specific weight per power output ratio) and its nonmagnetic property. Author

N64-21421* Hughes Aircraft Co., Culver City, Calif.
MANUAL ATTITUDE CONTROL SYSTEMS: PARAMETRIC AND COMPARATIVE STUDIES OF OPERATING MODES OF CONTROL
R. O. Besco, G. G. Depolo, and D. K. Bauerschmidt Washington, NASA, Jun. 1964 64 p refs
(Contract NASw-620)
(NASA-CR-56)

Analysis and experimental investigations of several operating modes of manual attitude-control systems were conducted to: (1) define parameters critical to system performance; (2) find optimum values of these parameters; and (3) provide comparative performance data among the various control modes. Representative attitude-control maneuvers were performed by experienced pilots in a fixed-base, spacecraft sumulator. Studies were conducted concerning: (1) parameter optimization of a single-pulse mode of control; (2) parameter optimization of a repeated-pulse mode of control; (3) system performance trends as a function of the ratio between the level of control system torque and the amplitude level of disturbance torques; and (4) comparative evaluations of five types of manual control modes. The results of these studies and their implications for design of manual attitude-control systems are presented. Several normalizing parameters and definitions are presented to enable analytical performance evaluations among different modes of control. Author

N64-21450 Texas Instruments, Inc., Dallas
SOLID-STATE COOLING OF FUNCTIONAL ELECTRONIC BLOCKS
Wright-Patterson AFB, Ohio, AF Avionics Lab., 7 May 1964 42 p refs
(Contract AF 33(657)-8588)
(Rept.-20-74300-20; AL-TDR-64-71; AD-439203)

Techniques for fabrication of thermoelectric coolers in sizes comparable to solid-state network circuit blocks were investigated. Two laboratory methods for deposition of films of bismuth telluride by vacuum evaporation were devised. These

are multiple boat evaporation of tellurium and bismuth at controlled rates and flash evaporation of a mixture of the materials from a hot filament. Films up to 0.0003-in. thick were made. The principal problem encountered was differential thermal contraction between film and substrate during cooling. Glass substrates were used in the experiments. An improved substrate material is needed. Prototype thermoelectric coolers were fabricated by two methods, photoetching of raw material sheets to provide individual elements and manual assembly of individual elements in an epoxy matrix. The latter method was the more successful. Author

N64-21464 Eagle-Picher Co., Joplin, Mo. Couples Dept.
INVESTIGATIONS LEADING TO THE DESIGN OF A RELIABLE SEALED NICKEL-CADMIUM CELL Third Quarterly Progress Report, Nov. 1, 1963–Jan. 31, 1964
C. O. Gosch 28 Feb. 1964 79 p
(Contract DA-36-039-AMC-00135(E))
(Rept.-7; AD-408569)

The design experiment was delineated, and the response data were detailed for the following factors: electrolyte concentration, additives, type of sintered plaque, type of separation, type of negative plate, and type of cell. An additional design experiment detailed type of negative plate, type of separation, electrolyte concentration, and additive to the positive plaque. Cell responses were recorded, and the influence of the various parameters are shown. Author

N64-21468 Yardney Electric Corp., New York, N.Y.
DEVELOPMENT OF THE SEALED ZINC-SILVER OXIDE SECONDARY BATTERY SYSTEM Second Quarterly Progress Report, 1 Oct.–30 Dec. 1963
Martin Sulkes and George A. Dalin [1963] 83 p refs
(Contract DA-36-039-AMC-02238(E))
(Rept.-2; AD-600395)

Sealed silver–zinc cells of standard construction when cycled at 120° F had poor capacity maintenance, due to separator deterioration. Cells cycled at room temperature showed poor charge acceptance at high rates of charge. Studies of the reaction of oxygen with zinc in 12AH cells indicated that the maximum overcharge rate possible with standard construction is 60 to 90 ma or 1.2 to 1.8 ma/in^2. The recombination reaction was found to be limited by the diffusion of oxygen through the electrolyte. In the range of concentrations tested, 26.5% to 44% KOH, the lower the concentration the greater the rate of recombination. Data are presented on the physical, chemical, and electrical properties of separators and interseparators. The use of one layer of high-resistance membrane as a separator is not feasible. Most of the cells built with a single turn of irradiated polyethylene shorted during the first charge. Positive electrode surface areas were studied by double-layer capacitance. The result indicated that the area increase takes place during discharge. Author

N64-21486 Lockheed Missiles and Space Co., Palo Alto, Calif. Materials Sciences Lab.
LITHIUM ANODE LIMITED CYCLE SECONDARY BATTERY Quarterly Technical Progress Report No. 3
H. F. Bauman 14 Mar. 1964 14 p refs
(Contract AF 33(657)-11709)
(AD-433543)

The lithium–cupric fluoride and lithium–cobaltic fluoride couples are being investigated for development into high energy battery systems for space applications. These two couples are of interest because of their high energy to weight ratio—746 whr/lb for the Li-CuF couple and 970 whr/lb for the Li-CoF couple. The development goal is a battery discharging between 22 and 30 v and delivering 300 whr/lb during 100-hr discharge. The battery should be capable of recharge and another discharge. Studies discussed are: electrolytes, lithium anode polarization, cupric fluoride cathode polarization, and cell tests with profiled discharge. N.E.A.

N64-21489 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
A PROBE FOR THE INSTANTANEOUS MEASUREMENT OF SURFACE TEMPERATURE [Final Report] 11 Jun. 1962–31 Jul. 1963
Gerald A. Sterbutzel, John R. Shoemaker, Robert C. MacArthur, Henry M. Korytkonski, Franklin A. Vassalo et al Wright-Patterson AFB, Ohio, Res. and Technol. Div., Jan. 1964 93 p refs
(Contract AF 33(657)-8745)
(RTD-TDR-63-4015; AD-431314)

This report describes the design, development, and evaluation of a probe system with which instantaneous temperatures can be measured on a variety of surfaces heated by radiation. It discusses a 1,000° F system, its methods of operation, and its performance characteristics. A comparison of the performance of permanent surface thermocouple installations using iron–constantan, chromel–constantan, and chromel–alumel thermocouples, various thermocouple wire sizes, orientations, rates of heating, and surface materials was made with the 1,000° F probe performance. In almost every case, the accuracy of the probe was better than the accuracy of permanent surface thermocouple installation. The design of a probe system believed to be feasible for extending the range of operation to 3,000° F is presented. The report also includes detailed information on the development of the sensor, fabrication of a probe, and a discussion of thermocouple attachment methods to nonmetallic surfaces. Author

07 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis. *For related information see*: 18 Materials, Metallic; 19 Materials, Nonmetallic; and 26 Propellants and Combustion.

N64-20786* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
CHEMICAL CORROSION PROCESSES
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 27–34 (See N64-20783 14-01) OTS: $5.00

This is a discussion of the role in corrosion processes of impurities in alkali metal systems. The importance of iron-base alloys in liquid materials is noted. Examples are given of the shift from diffusion to chemical reaction processes as the determinant of solution rate. The assumption is made that whenever a trace amount of impurity has a very strong effect on corrosion, a chemical process is responsible for the behavior of the system. Refractory metals—columbium, zirconium, molybdenum, titanium, etc.—form strongly acidic oxides readily combinable with alkali oxides to form rather stable niobates, zirconates, etc. It can reasonably be predicted that corrosion will be chemically controlled in these systems, and that the effect of oxygen as an impurity will be important in determining the behavior of the system. A.W.

N64-20787* Columbia U., New York, N.Y.
MECHANISMS IN LIQUID-PHASE CORROSION. A: DIFFUSION CONTROLLED
Charles F. Bonilla *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 35–43 refs (See N64-20783 14-01) OTS: $5.00

The two typical situations in which diffusion control can occur are: (1) pure molecular diffusion of the solute molecules throughout a whole quiescent body of the liquid metal; and (2) transport of the solute away from the corroding area by flowing or stirred solvent. It is necessary to arrive at the diffusivity of the solute in the solvent in correlating or predicting diffusion-controlled corrosion. Knowing this and the situation in which diffusion control can occur, one can estimate the mass-transfer coefficient for a corrosion situation. Heat-transfer correlations can be translated into mass-transfer correlations. Prediction of rate and amount of corrosion must be left to mathematical equations of dissolving and precipitating and flow transport. A.W.

N64-20788* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
MECHANISMS IN LIQUID-PHASE CORROSION. B: SOLUTION CONTROLLED
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 45–47 (See N64-20783 14-01) OTS: $5.00

The author formulates quantitative relations that are equally applicable to corrosion determined by solution rates and to corrosion determined by diffusion rates. A.W.

N64-20789* Brookhaven National Lab., Upton, N.Y.
EFFECTS OF IMPURITIES. A: OXYGEN
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 49–57 (See N64-20783 14-01) OTS: $5.00

In alkali metals oxygen may have either or both of two effects: (1) acceleration of corrosion by catalyzing dissolution of the solid metal atoms; or (2) become the major migrating constituent. The activity of oxygen in the liquid metal at any given temperature can be assumed equal from Henry's law to the fraction of solubility of the dissolved phase present. Calculations are made for several systems. Alkali metals tend to form spinels with many transition metals, and the stability of these spinels may add an important free-energy term in the calculations. Oxygen solubility is higher in the heavier alkali metals. It is suggested, therefore, that traces of oxygen may be more difficult to remove than had been thought. A.W.

N64-20790* Brookhaven National Lab., Upton, N.Y.
EFFECTS OF IMPURITIES. B: NITROGEN AND HYDROGEN
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 59 (See N64-20783 14-01) OTS: $5.00

In alkali metals, nitrogen may either accelerate dissolution or become the migrating constituent. These effects are considered in selected alkali metals. Hydrogen embrittlement of fuel elements occurred at T<300° C in Dounreay from H_2O in cover gas. Hydrogen may also react in conjunction with oxygen in accelerating corrosion of iron by sodium. A.W.

N64-20791* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
EFFECTS OF IMPURITIES. C: CARBON
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 61–65 (See N64-20783 14-01) OTS: $5.00

This is a discussion of the role of carbon as an impurity in high-temperature service in sodium. It is now thought that the behavior of carbon rather than oxygen impurity may well determine the upper-temperature limit attainable in sodium systems. Techniques for determination of carbon in sodium are wet combustion and dry combustion, but results have been disappointing in both, and the nature of carbon in alkali metals and its reactions are essentially still unknown. A.W.

N64-20792* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
EFFECTS OF IMPURITIES. D: INHIBITORS AND ACCELERATORS
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 67–71 (See N64-20783 14-01) OTS: $5.00

The author discusses the manner in which dissolved titanium and zirconium inhibit the corrosion of ferrous alloys in liquid mercury, lead, and bismuth. The acceleration of corrosion processes in the alkali metals by certain trace impurities appears to be parallel to this inhibition process. The liquid metal itself is not always the sole source of the oxygen and of nitrogen impurities that bring about accelerated corrosion. The search for specific inhibitors in the alkali metals has not been extremely successful to date. At the present time, the best technique for inhibiting corrosion in these metals is elimination of oxygen in the system. A.W.

N64-20798* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
SPECIAL TOPICS. A: DOWNSTREAM EFFECT
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 91–95 (See N64-20783 14-01) OTS: $5.00

A series of pumped loops of various steel alloys displayed isothermal regions of considerable length at various points in the flow pattern. The corrosion rate was highest near the beginning of the constant temperature zone, and decreased from this point. This is the downstream effect, the exact nature of which is still obscure, and is discussed in this paper only as an interesting example of a new discovery in what was thought to be a thoroughly explored and well-understood field. A.W.

N64-20801* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
SUMMARY AND CONCLUSIONS
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 105–106 (See N64-20783 14-01) OTS: $5.00

The physical and chemical origins of the basic phenomena of liquid-metal corrosion are understood. In only a very few cases are quantitative predictions of corrosion rates possible. Certain specific phenomena (e.g., the downstream effect) are still obscure. There are many aspects of sodium and bismuth and other alkali metals that require clarification. Additional experiments must be made on two-phase liquid-vapor systems. A.W.

N64-20803* Brookhaven National Lab., Upton, N.Y.
COMPATIBILITY TESTS WITH ALKALI METALS
David Gurinsky *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 127–252 (See N64-20783 14-01) OTS: $5.00

This paper contains the results of compatibility tests with alkali metals; capsule and loop tests were used. Questionnaires were completed as to purpose, type, fluid, major problems encountered, and analyses of results. A.W.

N64-20805* Oak Ridge National Lab., Tenn.
HYDRODYNAMIC AND THERMAL INFLUENCES IN CORROSION STUDIES
H. W. Hoffman *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 273–303 refs (See N64-20783 14-01) OTS: $5.00

Consideration is given to the influence of heat transfer and fluid mechanics on dynamic corrosion. Comments based on specific experiments are made on: (1) the role of surface shear and boundary-layer flow and development with uranyl sulfate solutions; (2) the effects of surface temperature oscillations on the mechanical integrity and corrosion resistance of an alloy metal wall in a molten-salt environment; and (3) flow and temperature phenomena that could affect corrosion in a boiling alkali-metal system. A.W.

N64-20831 Liège U. (Belgium)
LIQUID-LIQUID EXTRACTION BY ALKYL-PHOSPHINE OXIDES [L'EXTRACTION LIQUIDE-LIQUIDE PAR LES OXYDES D'ALKYLPHOSPHINE]
G. Duyckaerts and J. Goffart Brussels, European Atomic Energy Community, Feb. 1964 87 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-003-61-2 TPU-B)
(EUR-437.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account no. 121.86: 125 Belg. Fr.

The determination of actinide and lanthanide nitrates extraction from a nitric solution into a tri-n-octyl- or tri-n-butylphosphine oxide organic solution has been investigated; the results obtained for Am, La, Ce, Pm, Eu, Gd, Tb, Ho, Er, Tm, Yb, Lu, and Y are discussed. The extracted complex has the formula $Me(NO_3)_3.3$ TBPO. To obtain a quantitative interpretation of these distribution curves and to determine the stability constants of these complexes, it is necessary to know the HNO_3, TBPO, H_2O distribution between the two phases. This study allowed the determination of the apparent stability constants for two molecular complexes. Author

N64-20855 Rice U., Houston, Tex.
RESEARCH IN FLUORINE CHEMISTRY Progress Report No. 3, 1 Jan.–31 Mar. 1964
John L. Margrave [1964] 9 p refs
(Contract DA-31-124-ARO(D)-110; ARPA Order 40)
(AD-439596)

The results of research in the following areas are summarized: (1) fluorine bomb calorimetry, (2) vapor pressures of fluorides, (3) high-temperature heat contents and entropies of fluorides, (4) preparation and properties of SiF_2, (5) plasma reactions of halocarbons, (6) reactions of elementary fluorine, and (7) high-pressure chemistry. R.T.K.

N64-20864 Avco-Everett Research Lab., Everett, Mass.
A PARTIAL-DISSIPATION APPROXIMATION FOR CHEMICAL REACTIONS IN HETEROGENEOUS TURBULENT FLOWS Research Report No. 180
Shao-Chi Lin Apr. 1964 51 p refs
(Contracts AF 04(694)-414; DA-19-020-AMC-0210; ARPA Order 525; Proj. Defender)
(BSD-TDR-64-59; AD-439895)

The approximate method consists of dividing, in a statistical sense, into two distinct volume fractions any given fluid element—a fraction Ψ that survives the viscous dissipation process, and another fraction $(1-\Psi)$ that does not. The Lagrangian time history for the chemical reactions in the volume fraction Ψ is assumed to be identical to that in an inviscid streamtube flow in spite of the convective distortions. The chemical reaction history for the remaining fraction $(1-\Psi)$ is to be determined by the local reaction rates in a homogeneous mixture of all the neighboring fluid elements that have suffered viscous dissipation. The spatial variation of Ψ is then determined by a competition between the local rate of production of inhomogeneity due to turbulent transport and the rate of depletion of inhomogeneity due to viscous dissipation. For quasi one-dimensional flows, the governing equation for Ψ reduces to a first-order ordinary differential equation that can be integrated easily. Author

N64-20876 European Atomic Energy Community, Brussels (Belgium)
DETERMINATION OF THE COBALT CONTENT OF A SOLUTION BY MEANS OF DIFFERENTIAL SPECTROPHOTOMETRY [DETERMINATION DE LA TENEUR EN COBALT D'UNE SOLUTION PAR SPECTROPHOTOMETRIE DIFFERENTIELLE]
A. Brück, K. F. Lauer, and Y. Le Duigou Joint Nucl. Res. Center, Geel Estab. (Belgium) Central Nucl. Meas. Bur., Mar. 1964 7 p refs In FRENCH, ENGLISH summary
(EUR-581.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 25 Belg. Fr.

Differential spectrophotometric measurements are made of the coloration of two solutions differing in their cobalt content by about 55 μg. The standard colorimetric procedure with ammonium thiocyanate as reagent is used. The calibration factor can be measured with a precision of ± 0.77%. Very good precision is obtained, depending on the number of measurements made. The statistical treatment of the results reported for 50 mg cobalt sample gives a standard deviation on the mean value (95% confidence level) of about 0.06 to 0.1%. The absolute value depends on the precision and accuracy with which standard cobalt solutions can be prepared. The method can be applied to other cobalt contents using a calibration factor based on the corresponding new reference solutions. Author

N64-20878 European Atomic Energy Community, Brussels (Belgium)
THE CHROMATOGRAPHIC CONCENTRATION AND THE SPECTROGRAPHIC DETERMINATION OF TRACES OF CADMIUM, YTTRIUM, SCANDIUM AND LANTHANONS IN URANIUM METAL
Ch. A. Berthelot, S. Herrmann, K. F. Lauer, and R. A. A. Muzzarelli Joint Nucl. Res. Center, Ispra Estab. (Italy) Central Nucl. Meas. Bur., Feb. 1964 27 p refs
(EUR-587.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 50 Belg. Fr.

The cadmium and rare earths from 30-gs-uranium metal are concentrated on a 20-gs-cellulose column; the residual uranium is eluted using ethyl ether containing 5% of nitric acid. The activated cellulose is ignited at 500° C. One part of the ashes is mixed with zinc oxide for the spectrographic determination of cadmium. The other part is mixed with lithium carbonate for the spectrographic determination of scandium, yttrium, and lanthanons. The limits of detection are: 0.5 ppb for Yb and Sc; 2 ppb for Dy, Er, Eu, and Y; and 5 ppb for the other rare earth metals and Cd in uranium. The problem of lanthanum in uranium, when used as internal standard, is discussed. Author

N64-20922 Joint Publications Research Service, Washington, D.C.

METHOD OF WEIGHT AND THICKNESS DETERMINATION OF ANODIC OXIDE FILMS ON TITANIUM

T. V. Matveeva and V. A. Pavlova *In its* A Modification of Aluminum and Titanium Alloys 15 May 1964 p 19–23 refs (See N64-20919 14-18) OTS: $1.00

During an investigation of the principles of the process of the anodic oxidation of titanium, depending upon the conditions of anodizing, a method was developed for the removal of oxide films from the surface of titanium samples, with insignificant dissolution of the metallic titanium. The optimum conditions for the film removal are a 20% solution of orthophosphoric acid with the addition of 0.1% chromic anhydride, temperature of solution at 80° C, and cathode polarization at a current density of 2.5 ma/cm^2 until the appearance on the sample of the first sections without film, after which a current density of 1.5 ma/cm^2 is maintained until full removal of the film. The decrease in weight of the samples, after film removal, corresponds to the weight of the film. The thickness of the film is derived from its specific gravity. I.v.L.

N64-20925 Joint Publications Research Service, Washington, D.C.

THE SEPARATION AND DETERMINATION OF ZIRCONIUM AND THORIUM

Chang-kuang *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 10–12 refs Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 164 (See N64-20924 14-01) OTS: $3.00

Organic precipitation, separation, and determination of zirconium and thorium were investigated. It was found that, in the presence of strong hydrochloric acid under heat treatment, zirconium and iodine phenyl formic acid form a white, cotton-like precipitate. When the hydrochloric acid concentration is between 0.1 to 0.16 N, zirconium can be precipitated quantitatively. When the acidity is greater than 0.16 N, then the zirconium precipitation is incomplete; at less than 0.1 N, part of the thorium is coprecipitated. Thorium can give a quantitative precipitation in a weak acid (pH > 2.2). The determination can be continued by controlling the solution acidity; thus thorium and zirconium can be separated. I.v.L.

N64-20927 Joint Publications Research Service, Washington, D.C.

SOME CHARACTERISTICS AND LAWS ON CATALYTIC CHROMATOGRAPHY. INVESTIGATIONS OF PROPYLENE HYDROGENATION ON Ni-SiO_2

Chang-su, Lou Nan-ch'uan, and Chang Ta-yu *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 26–36 refs Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 175–178 (See N64-20924 14-01) OTS: $3.00

Catalysis chromatography is due to the interaction between catalysis and chromatography separation. The catalysis chromatography of propylene hydrogenation was investigated, and for the first time the shift in product retention time (t_r), called the reaction time, and the separation effect (t_{sr}, given in time units) are pointed out. The reaction separation effect and the reaction velocity constant are obtained, and are expressed in the concept of product chromatography's center of gravity. This is the first indication of the possibility of using catalysis chromatography to study the kinetics of catalysis. An investigation of the change of t_r with parameters shows the following laws: (1) The t_r decreases when the temperature increases. (2) The reaction material and the catalyst contact time are increased so that the hydrogenation rate is increased when the speed of flow is changed. This relation agrees with the concept that the reaction is a first-order reaction with respect to propylene concentration. The t_r is not influenced by the speed of flow. (3) Hydrogenation activity increases as the Ni concentration of the Ni–SiO_2 catalyst increases. At the same time t_r decreases relatively. (4) Poison has a marked effect on t_r. When the hydrogenation speed is decreased due to the adsorption of small quantities of poison, t_r is increased relatively. I.v.L.

N64-21045 Joint Publications Research Service, Washington, D.C.

OPTICAL ANISOTROPY AND CONFORMATION OF MOLECULES OF SOLUBLE (TRANSFER) RIBONUCLEIC ACID (S-RNA)

V. N. Tsvetkov, L. L. Kiselev, L. Yu. Frolova, and S. Ya. Lyubina 29 May 1964 6 p refs Transl. into ENGLISH from Vysokomol. Soedineniya (USSR), v. 6, no. 3 Mar. 1964 p 568–570 (JPRS-24844; OTS-64-31370) OTS: $0.50

A study was made of the double refraction in the flow of S-RNA in aqueous and buffer solutions. Double refraction was considerable in value, was negative, and corresponded to the segmental anisotropy of the molecule a_1–a_2, which equals $-1800 \cdot 10^{-25}$ cm^3. The existence of such great negative anisotropy indicates a high degree of order of the planes of the bases normally in the direction of the S-RNA chain. As distinct from ribosome RNA, the conformation of the S-RNA molecule in water solutions is close to the form of a straight rod with ordered secondary structure. Author

N64-21052 Aeronautical Research Labs., Melbourne (Australia)

THE DETERMINATION OF THE SOLUBILITY OF ZINC OXIDE IN VARIOUS SOLUTIONS BY ATOMIC ABSORPTION SPECTROSCOPY

L. Wilson May 1963 20 p refs (ARL/MET-17)

Atomic absorption spectroscopy has been successfully applied to the determination of the solubility of zinc oxide in various solutions. The effects of pH and anion on the absorption due to zinc have been determined, and a brief discussion on the effect of anions on the solubilities of zinc oxide and zinc hydroxide is included. Author

N64-21086 Bell and Howell Research Center, Pasadena, Calif.

MASS SPECTROMETER OUTPUT INTERPRETATION Technical Documentary Report, 1 Apr. 1962-31 Oct. 1963

George D. Perkins Wright-Patterson AFB, Ohio, Res. and Technol. Div., Oct. 1963 27 p (Contract AF 33(657)-8174) (RTD-TDR-63-4128; AD-428014)

The output of a mass spectrograph is a photographic plate containing a large number of spectral lines. To obtain the two most important bits of data per line necessary for converting an exposed photographic plate into a sample analysis, an optical and mechanical system was fabricated. This device measures a spectrum line position to 1/10,000 in. and measures its relative light transmission to 0.1%. It is primarily intended to acquire these data rapidly and easily, and thereby shorten the time of analysis of solid samples. Its accuracy was tested on a few sample runs with satisfactory results being obtained. A tabulation of 206,201 possible ionic species was made and stored on magnetic tape for cataloging according to the needs of the individual mass spectroscopist. Author

N64-21221 University Coll., London (Gt. Brit.)

ONE-DIMENSIONAL X-RAY DIFFRACTION TECHNIQUES AS A ROUTINE STEREO-CHEMICAL TOOL Final Report No. 1, 1 Dec. 1962-30 Nov. 1963

R. S. Nyholm, Peter Pauling, G. B. Robertson, and Jean Dollimore 1 Dec. 1963 132 p refs
(Contract DA-91-591-EUC-2775)
(AD-432314)

The objective of this investigation is to develop and evaluate techniques for obtaining information on the structure of molecules by use of one-dimensional X-ray diffraction data from crystalline powders, solutions, and liquids, and to obtain such information on the structure of molecules, with particular reference to coordination compounds. In connection with this work, a number of crystal structures by single-crystal diffraction techniques have been analyzed. A fully automatic one-dimensional diffractometer for powders, liquids, and solutions to collect high quality one-dimensional diffraction data and to present it in digital form for direct reading by a digital computer is discussed. A system for the use of large computers for single-crystal crystallographic calculations has been designed and developed, and a detailed specification of this system is presented. N.E.A.

N64-21270* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THERMOPHOTOTROPISM IN CORTICATED ALKALINE EARTH TITANATES
J. B. Schutt, J. A. Colony, and D. R. Lepp (Tagg Designs, Inc.) Washington, NASA, Jun. 1964 9 p ref
(NASA-TN-D-2306) OTS: $0.50

A comparison of acidic and acidic-to-basic impurity introduction on the thermophototropic behavior of the alkaline earth titanates is presented. The latter is a new method of introducing impurities into alkaline earth titanates that involves the synthesized titanate or titanyl oxalate. This method gave a considerably enhanced absorptivity change for barium titanate, but proved to be much less effective for the titanates of calcium and strontium. In all cases, the slurries were made alkaline with alkali metal hydroxides. For barium titanate the optimum alkalinity was obtained with 10-mole-percent sodium hydroxide, which led to the conclusion that the phenomenon is a surface one in which the alkali metal oxide corticates the surfaces of the host crystals. Author

N64-21284 Joint Publications Research Service, Washington, D.C.
A STUDY ON HYDROXIDE PRODUCTION
S. I. Sklyarenko et al 3 Jun. 1964 13 p refs Transl. into ENGLISH from Zh. Prikl. Khim. (Leningrad), v. 37, no. 3, 1964 p 568–574
(JPRS-24912; OTS-64-31398) OTS: $0.50

A study is presented of the electrolysis of aqueous solutions of lithium chloride on a solid cathode in filtering diaphragm electrolyzers that can produce solutions of hydroxide all the way up to the saturated and even to the supersaturated solutions, with high current-based yield (95% to 99%). By evaporation, up to 50% of the hydroxide formed in the electrolysis could be separated as the monohydrate $LiOH \cdot H_2O$. The hydroxide remaining in the catholyte after part of it has been separated out in a solid form can be separated as the lithium carbonate by carbon dioxide saturation. It has been shown that the ratios that afford calculation of the current-based yield and of the chloride concentration in the catholyte have been well supported quantitatively, under the condition that the hydroxide concentration in the catholyte is less than is required for saturation at the given temperature. N.E.A.

N64-21321 University of Southern Calif., Los Angeles.
ENHANCEMENT OF P-H BONDING IN A PHOSPHINE BORING Technical Report No. 11
Anton B. Burg 1 Apr. 1964 8 p refs Submitted for Publication
(Contract Nonr-228(13))
(AD-434269)

Infrared absorption bands for N-H stretching have generally been observed at lower frequencies when nitrogen is bonded to four atoms rather than three. In phosphorus compounds, however, this rule seems to be reversed: four-coordinate phosphorus shows higher P-H stretching frequencies than are found for phosphines. For a more effective comparison of the P-H vs N-H contrast stretching modes, the BH complexes of $(CH_3)_2NH$ and $(CH_3)_2PH$ were studied. It was concluded that the lowering of the N-H stretching force constant for four-coordinate nitrogen is a real effect, contrasting to the increase for four-coordinate phosphorus. N.E.A.

N64-21362 Astropower, Inc., Newport Beach, Calif.
AN ACCIDENTAL EXPLOSION INVOLVING THE USE OF OXYGEN DIFLUORIDE
N. A. Tiner, W. D. English, and S. W. Pohl Nov. 1963 54 p refs
(Contract AF 33(657)-9162)
(Rept.-63-136; AD-425012)

This report describes an accidental explosion involving the use of oxygen difluoride resulting in the destruction of the long-term immersion tests and severe injury to the attending technician. The components in these tests that appear to be suspect as to the shock sensitivity of oxygen difluoride are: (1) test material that exhibited reactive tendencies—graphite, AGKSP grade, with impurity constituents such as Al, Cu, Fe, Mg, Si, etc., each less than 1 ppm; Titanium A110-AT containing Al 5.2, Sn 2.4, Fe 0.34, C 0.026, N_2 0.028, and H_2 0.015; tantalum containing O_2, 50 ppm; N_2, 30 ppm; C, 20 ppm; W, 50 ppm; Nb, 10 ppm; and Fe, 8 ppm; niobium containing Nb, 99.70; O_2, 0.03; N_2, 0.03; C, 0.01; and Ta, 0.05; and teflon FEP copolymer of tetrafluoroethylene and hexafluoropropylene; (2) support racks of Teflon TFE polymer of tetrafluoroethylene; (3) residues deposited in the bomb—oily residues previously found in test bombs in trace quantities, and sample residues that gradually dissolve in oxygen difluoride; and (4) impurities in the oxygen difluoride. Although the specific cause of the explosion remains unknown, certain suggestions are made to minimize some potential hazards associated with the use of this oxidizer. I.v.L.

N64-21393 Palermo U. (Italy) Inst. of Chemistry and Physics.
CONDUCTANCE OF SOME ALKALI HALIDES IN WATER-GLYCEROL AND IN WATER-ETHYLEN GLYCOL MIXTURES AT 25°C Final Technical Report, 1 Jan.-31 Dec. 1963
Filippo Accascina [1963] 57 p refs
(Contract DA-91-591-EUC-2810)
(AD-432997)

To extend some previous research, the electrical conductance of sodium chloride and of lithium chloride in water-ethylene glycol was measured. The water-ethylene glycol covered a range of dielectric constant equivalent to that of water-glycerol mixture with viscosity varying by a factor of 100 going from pure water to pure glycol. Author

N64-21398 Alfred U., N.Y.
HYDROGEN-OXYGEN ELECTRODE STUDY Quarterly Progress Report No. 9
T. J. Gray, R. B. Rozelle, M. L. Soeder, and M. W. Snow 15 Mar. 1964 11 p
(Contract AF 33(657)-7564)
(AD-432973)

The effect of platinization time and impregnation time on double-layer capacitance was investigated. Sintered Clevite nickel electrodes (8 mm x 12 mm) were washed in distilled water in the ultrasonic bath, and then impregnated with 3% chloroplatinic acid in the ultrasonic bath for various time limits; platinization was effected in this solution containing 0.1% lead acetate with a plating current of 45 ma. The platinized electrodes were rinsed with distilled water before the galvanostatic measurements were made. The electrolyte (30% KOH) was heated to remove dissolved oxygen and cooled under nitrogen prior to each day's work. Results indicate that the maximum effective catalyst area was obtained, at the indicated platinization current densities (approximately 47 ma/cm^2) when the impregnation time is in the vicinity of 4 to 5 min and platinization time is about 1 min. Also, galvanostatic studies were conducted on platinum–palladium codeposits. The 4% $PtCl_4$-4% $PdCl_4$ codeposit was predicted to be a better hydrogen-electrode catalyst for a fuel cell than those containing less palladium. I.v.L.

N64-21400 Gt. Brit. Ministry of Aviation, Mottingham Technical Information and Library Services
EXPLOSIVE REACTIONS IN CONDENSED SYSTEMS, 2. KINETICS OF THE THERMAL DECOMPOSITION OF TRINITROTOLUENE [VZRYVNYE REAKSII V KONDENSIROVANNYKH SISTEMAKH, 2. KINETIKA TERMICHESKOGO RAZLOZHENIYA TRINITROTOLUOLA]
S. Z. Roginskii and A. M. Magid Apr. 1964 14 p refs Transl. into ENGLISH from Zh. Fiz. Khim. (Moscow), v. 2, no. 2, 1931 p 262–274
(TIL/T-5435)

The reaction processes in TNT are more complicated than for trinitroglycerine. The region and conditions of autocatalytic reaction are studied in detail. The experimental method is described and results given for induction period, rate of growth, and other kinetic dimensions. Author

N64-21426* Stanford U., Calif. School of Medicine
TABLES AND AN ALGORITHM FOR CALCULATING FUNCTIONAL GROUPS OF ORGANIC MOLECULES IN HIGH RESOLUTION MASS SPECTROMETRY Interim Report
Joshua Lederberg 1 Apr. 1964 54 p refs
(Grant NsG-81-60)
(NASA-CR-57009) OTS: $5.60 ph

Joshua Lederberg has presented work concerning the high resolution mass spectrometric structural analysis of organic molecules and computation of molecular composition from the experimentally found mass. The work is directed toward calculating the mass of the noncarbon functional groups of organic molecules. Tables are given of the mass defects for integer residues based on the compositions of the functional groups of the molecules. An alternative approach is also given that provides more compact tables than these along with an algorithm that is more suitable for computer-oriented analysis. C.L.W.

N64-21458 Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
STUDIES OF THE SYNTHESIS OF COORDINATION POLYMERS
Okawara Rokuro 8 May 1964 16 p refs Transl. into ENGLISH from Kagaka no Ryuiki (Japan), no. 15, 1961 p 247–251
(RSIC-175; AD-440099)

The synthesis of inorganic polymers aimed at heat stabilities and the role of coordination polymers as part of inorganic polymers are considered. A polymer containing metallic atoms through coordination bonding in its repeating units is said to be a coordination polymer. Its synthesis is not new in principle and can be represented in a model way. It must be kept in mind that even if coordination links are introduced in the polymer chain, this may not have a positive effect on thermal stability. A.W.

N64-21461 Harshaw Chemical Co., Cleveland, Ohio Central Research Lab.
INVESTIGATION OF THE EXISTENCE OF OXYANIONS OF FLUORINE AND NITROGEN AND THE NITROGEN-FLUORINE CATIONS Quarterly Technical Summary Report, 28 Jan.-28 Apr. 1964
Gerald L. Hurst and S. I. Khayat 28 May 1964 18 p refs
(Contract DA-31-124-ARO(D)-76; ARPA Order 402)
(HQ-76-5; AD-423918)

The basic hydrolysis of nitrogen trifluoride probably proceeds via nucleophilic attack by OH^-. The rate of the reaction between nitrogen trifluoride and aqueous caustic soda is influenced by the surface area of the solution and the ionic strength. Nitrogen trifluoride does not react with pure water or pure HCl at 133° C, but it reacts slowly with aqueous HCl. The nature of the products varies with the concentration of the HCl. Nitrogen trifluoride at 133° C is unaffected by aqueous solutions of acids that yield weakly nucleophilic anions. Nitrogen trifluoride reacts with strong nucleophiles in aqueous solution. The rates of the reactions increase with increasing nucleophilicity. The rate of attack on NF_3 by aqueous halide ions is accelerated by H_3O^+. Nitrogen trifluoride is readily attacked by pure $AlCl_3$ at moderate temperatures, yielding nitrogen and chlorine. Dinitrogen tetrafluoride is more reactive than NF_3 toward water, aqueous HCl, and aqueous NaOH. Author

N64-21467 Research Triangle Inst., Durham, N.C. Camille Dreyfus Lab.
THE PROPERTIES OF GRAFT COPOLYMERS OF CELLULOSE AND ITS DERIVATIVES Final Report, Apr. 1, 1962-Mar. 31, 1964
V. T. Stannett 28 Apr. 1964 44 p refs
(Contract DA-ARO(D)-31-124-G283)
(AROD-3630-6; AD-439593)

Intensive study was made of graft copolymers of polystyrene and cellulose acetate. The kinetic and other features of the grafting process were examined in detail, including the role of the concurrent radiation degradation. Determination was made of some structural details and properties of the pure isolated graft copolymers, and it was found that heterogeneously prepared grafts have extremely long side chains due to delayed termination. The strong protective action of the monomer on the grafting reaction was shown. The grafts proved to be soluble in a number of pure and mixed solvents. Viscosity could be lowered by addition of nonsolvents. Graft copolymers tolerated the addition of both homopolymers and were capable of adhesion to them. A.W.

N64-21491 Stanford U., Calif. Solid-State Electronics Lab.
EPITAXIAL VAPOR GROWTH OF III-V COMPOUNDS Interim Technical Report No. 4711-1, Oct. 1961-Aug. 1963
James F. Gibbons and Preben C. Prehn Oct. 1963 52 p refs
(Contract AF 33(616)-7726)
(SEL-63-105; RTD-TDR-63-4238; AD-434756)

This work describes an open-tube method for epitaxial growth of III-V compounds using heterogeneous, gas–solid chemical reactions. Different techniques and reactions are briefly discussed, and a simplified model is exposed to a thermodynamic treatment to clarify how different parameters influence the growth process. The experimental apparatus

and procedure are outlined, and data are given for the growth of the two compound semiconductors, GaAs and GaP, as well as for the ternary $GaAs_xP_{1-x}$ mixtures. Also mentioned are the fabrication of heterojunctions, the possibilities of doping, and closed-tube growth processes. Author

08 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation. *For tracking stations see*: 10 Facilities, Research and Support. *For related information see*: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation and Photography; and 22 Navigation and Guidance.

N64-20859 Aerospace Corp., El Segundo, Calif.
IMAGE DESIGN FOR TERRAIN-MAPPING RADAR SYSTEMS
Jean A. Develet, Jr. 15 May 1964 16 p refs
(Contract AF 04(695)-269)
(SSD-TDR-64-94; TDR-269(9990)-6; AD-600084)

The theory of parameter estimation is applied to the problem of mapping radar image design. A postdetection processing technique guided by this theory yields quantitative interrelations among important final image parameters, i.e., number of gray levels of a specified confidence factor, dynamic range, and final image sample distance. In turn it is found that specification of the foregoing places sample distance and minimum SNR requirements on the raw radar data prior to processing. The formulas, table, and curves presented, although for an ideal terrain mapper, give insight as to the quantity of data necessary to produce terrain maps of a specified quality. Author

N64-20897 Lockheed Missiles and Space Co., Sunnyvale, Calif.
PCM TELEMETRY An Annotated Bibliography, 1959-1963
Peter R. Stromer, comp. Jan. 1964 45 p refs
(Contract NOw-63-0050-c)
(SB-64-6; Rept. 2-60-64-9; AD-439442)

Telemetering information from missiles and space vehicles requires systems of high accuracy, minimum power and bandwidth consumption, and adaptability and compatibility with computing equipment both on board the vehicle and at ground stations. The advantages of digital communication systems, especially pulse code modulated (PCM) telemetry, for the above purpose were demonstrated. The literature referenced herein contains comparative evaluations and optimization techniques for PCM, pulse amplitude modulation (PAM), pulse duration modulation (PDM), and pulse frequency modulation (PFM). Period of coverage is 1959 through 1963. A subject index is included. Author

N64-20902 Lincoln Lab., Mass. Inst. of Tech., Lexington
OPTIMIZATION OF SIGNALS Group Report 1964-4
F. C. Schweppe 16 Jan. 1964 49 p refs
(Contract AF 19(628)-500)
(ESD-TDR-64-18; AD-430345)

A general theory is presented for the design of optimum signal waveforms. Explicit constraints on the signal's energy, amplitude, and bandwidth are possible. The development is based on optimum control theory and employs the state variable concept with differential equations as basic models. Pontryagin's Maximum Principle provides a two-point boundary value problem whose solution gives the optimum signal. A communication problem of deciding which of M signals was transmitted, and a radar problem of deciding the range and range rate of a target are used as examples. Author

N64-20926 Joint Publications Research Service, Washington, D.C.
PREPARATION OF ORGANIC MATERIAL WITH VARIOUS ELEMENTS THROUGH BENZYNE. III SYNTHESIS OF ORGANIC MERCURY ANTIMONY COMPOUNDS THROUGH BENZYNE
Tseng Chao-lun, Tung Shih-hua, and Chang Kuo-min *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 13–18 refs Transl. into ENGLISH from K'o-Hsueh T'ung Pao (Peking), no. 2, 1964 p 165–166 (See N64-20924 14-01) OTS: $3.00

This paper reports the direct interaction of benzyne with mercuric chloride (text refers to mercurous chloride but the formula is that of mercuric chloride), phenyl mercurous chloride, and tri-n-butyl antimony chloride. (Text refers to antimony chloride but the formula is that of stannic chloride.) The products formed are ortho-di(chlorophenyl) mercury, ortho-chlorophenyl phenyl mercury, and ortho-chlorophenyl tri-n-butyl antimony, respectively. (The formula is that of ortho-chlorophenyl tri-n-butyl tin.) I.v.L.

N64-21007 Hazeltine Corp., Little Neck, N.Y. Hazeltine Electronics Div.
SMALL LIGHT-WEIGHT ALTITUDE TRANSMISSION EQUIPMENT Final Engineering Report
15 Apr. 1964 83 p
(Contract FAA-ARDS-558)
(Rept. 10136)

The design and development of the Small Light-Weight Altitude Transmission Equipment SLATE III and SLATE III Mark I for the FAA is described. The equipments operate at a transmitter frequency of 1,090mc with a nominal peak power output of 300w, and a receiver frequency of 1,030mc with a nominal sensitivity of −74dbm. SLATE III replies to Mode A (Identity) or Mode C (Altitude) interrogations. The reply codes include any of 64 codes (00 to 77) plus the Special Position Identification (SPI) or "IDENT" pulse on Mode A, and 158 codes on Mode C (altitude reporting at 100-ft intervals from −1,000 to 14,700 ft). Circuits are included that automatically prevent altitude reporting at 14,800 ft and above so that erroneous information will not be transmitted. Operation of the receiver and video processing and transmitter circuits is the same for both modes of operation. The decoding and reply encoding circuits function to cause transmission of replies to Mode A or Mode C interrogations on a first-come, first-served basis. The SLATE III Mark I is identical to the SLATE III equipment except that it replies to Mode A interrogations on any of 4,096 codes (0000 to 7777), and that a different control box is provided. Additional wiring, diodes, capacitors, and resistors were added in the SLATE III Mark I receiver–transmitter unit for selection of the additional information pulses. Author

N64-21044 Joint Publications Research Service, Washington, D.C.
NEW RADAR EQUIPMENT
V. Krasnov 29 May 1964 9 p Transl. into ENGLISH of a Review in Radio (Moscow), no. 4, Apr. 1964 p 57–58
(JPRS-24841; OTS-64-31367) OTS: $0.50

This review article describes modern radar equipment and its uses. In addition to the searching for and spotting of objects, radar stations permit the determination of coordinates of objects and make possible the automatic observation of their movements. Radar control is used to aim rockets, to

control artillery fire, to solve navigational problems in ocean shipping, and in the piloting of aircraft. The effectiveness of antiaircraft defense has increased considerably because of the use of radar. The range of radar control has also been increased due to the increased sensitivity of receiving channels, to utilization of electronic computers for processing the information received, to the increased power of pulsed radiation of the radar station to 50 to 70 milliwatts, and to the improved indicator devices. Various antenna arrays and their properties are also described. R.T.K.

N64-21050* National Aeronautics and Space Administration, Washington, D.C.
HIGHLIGHTS OF NASA COMMUNICATIONS AND ELECTRONICS PROGRAMS News Release
James E. Webb 20 May 1964 9 p Address before the Armed Forces Commun. and Electron. Assoc., Washington, D.C.
Available from the Scientific and Technical Information Division

According to James E. Webb, Administrator, National Aeronautics and Space Administration, it has been estimated that about 40% of the NASA booster costs, 70% of the major spacecraft dollars, and 90% of the tracking and data acquisition funds go into electronics. A vast majority of flight failures and delays arise from electronic failures. The space program and the role that information systems and electronic systems play in it are outlined. The Electronics and Research Center that NASA plans to establish in Boston is described. R.T.K.

N64-21062 General Electric Co., Philadelphia, Pa. Space Sciences Lab.
PROPAGATION AND SCATTERING OF RADIO WAVES IN TURBULENT MAGNETO-IONIC MEDIA
Leonard S. Taylor Mar. 1964 25 p refs
(R64SD17; AD-433098)

The Ewald–Oseen Extinction Theorem is generalized to account for electromagnetic propagation in a turbulent magnetoionic medium. Using the Born single-scatter approximation, the effective dielectric constant for the medium is determined. The scattered field was derived and a general expression for the second-order term in the Born series was obtained. Author

N64-21065 California U., Los Angeles Western Management Science Inst.
A CONDITION FOR OPTIMALITY IN SEQUENTIAL SIGNAL DETECTION Working Paper No. 46
K. B. Gray Dec. 1963 7 p refs
(Contract Nonr-233(73))
(Res. Rept.-46; AD-433124)

The following problem is considered: A signal is of the form $\Theta s(t)$, where $s(t)$ is a known function of time t and Θ is an unknown parameter. Noisy observations $X = \Theta s(t) + N_t$ are made at times $t = 1,2,3,\ldots$. On the basis of these observations, one must decide between the alternative hypotheses $H_0{:}\Theta=\Theta_0$ $H_1{:}\Theta=\Theta_1$ for $\Theta_0=\Theta_1$. Sequential sampling is allowed. At each time t, one must decide to stop making observations and postpone making a decision between H_0 and H_1. It is assumed that the noise process N_t, contaminating the observations, is white and gaussian, with mean zero and variance σ^2. A decision procedure δ is a rule that maps the observations $X_1, X_2, \ldots, X_t$ into one of the three available actions (continue sampling, stop and accept H_0, and stop and accept H_1). It is shown that under certain conditions, the sequential probability ratio test for the decision procedure is optimal. R.T.K.

N64-21066 Michigan U., Ann Arbor Inst. of Science and Technology
APPLICATION OF SWEPT-FREQUENCY MODULATION TECHNIQUES TO PCM TELEMETRY Final Report, May 1962-Aug. 1963
E. K. Holland-Moritz and J. C. Dute Wright-Patterson AFB, Ohio, AF Avionics Lab., Jan. 1964 122 p refs
(Contract AF 33(657)-8840)
(RTD-TDR-63-4126; AD-432244)

This report gives design criteria for the application of the SFM technique to practical PCM telemetry systems. It compares optical, acoustic, and electrical techniques for generating and processing SFM signals, and it discusses the effects of Doppler shift and multipath propagation on PCM/SFM signals. Error rates were calculated for a PCM/SFM telemetry link operating in the presence of simultaneous gaussian and impulse noise. Errors due to single impulses, clusters of impulses, periodic impulses, and impulses having a Poisson distribution are treated. Computations are given for the approximate error rate when short channel interruptions or short fading periods are present. Consideration of the effects of impulse noise on SFM systems indicated certain factors that may improve the performance of conventional PCM systems. Some of these factors are: clipping, the use of more than minimum bandwidth, and an awareness of the significance of the average number of noise pulses occurring during a bit period. In addition, parallel PCM, in which the bits are frequency-division multiplexed, reduces the effects of impulse noise. Reliable operation of PCM/SFM telemetry systems over both AM and FM links was demonstrated under conditions that would have made a conventional PCM link unusable. Author

N64-21084 Technical Research Group, Inc., East Boston, Mass.
APPLICATION OF FRESNEL ZONE THEORY TO MICROWAVE ANTENNA DESIGN Scientific Report No. 3
Alan F. Kay 15 Nov. 1962 38 p refs
(Contract AF 19(604)-8057)
(AFCRL-62-950; AD-296973)

Some fundamental formulas are derived that are corrections to geometrical optics for radiation from bounded wave fronts. These formulas apply in both the near and far field, in focal and caustic regions, and in lit, twilight, and dark zones. Applications are made to improving the gain of a spherical reflector and to the analysis of (generally unwanted) focusing of spillover energy in microwave systems. Author

N64-21088 Georgia Inst. of Tech., Atlanta Engineering Experiment Station
COMMUNICATIONS INTERFERENCE REDUCTION STUDY Final Report
W. B. Warren, Jr. 3 Dec. 1962 104 p refs
(Contract AF 30(602)-2366)
(RADC-TDR-62-631; AD-298118)

This report describes a collection of techniques that are effective in reducing or eliminating the effects of pulse and CW interference to communications and measurements receivers. The techniques covered include (1) blankers, (2) RF limiters, (3) cavity preselectors, (4) selective RF preamplifiers, (5) linear mixers, (6) tunnel diode mixers, (7) special audio filters, and (8) modifications to the R361 communication receiver. Author

N64-21117 Michigan U., Ann Arbor Radar Lab.
A TABULATION OF CERTAIN PROLATE SPHEROIDAL ANGLE FUNCTIONS AND THEIR ASSOCIATED CHARACTERISTIC VALUES

Robert O. Harger and Thomas R. Crimmins Mar. 1964 13 p refs
(Contract AF 33(616)-8365)
(Rept.-4563-65-T; AD-432165)

This report tabulates the prolate spheroidal angle functions of the first kind (of order zero and degree zero) and gives their associated characteristic values. The characteristic value is given for c = 1/2, 8(1/2) to six significant figures. The functions [$S_{00}(c; x)$] are given for c = 1/2, 5(1/2) and x = 1/40, 5 1/40(1/20); the number of significant figures varies from at least four (for low values of c) to one (for c = 5).
Author

N64-21118 General Electric Co., Philadelphia, Pa. Re-Entry Systems Dept.
TIMM DATA STORAGE SYSTEM
R. Lamb et al N. Mex., Kirtland AFB, Res. and Technol. Div., Feb. 1964 174 p refs
(Contract AF 29(601)-6043)
(RTD-TDR-63-3104; AD-432413)

This document describes a data-gathering apparatus, namely a magnetic-tape-recorder system, that will be extremely insensitive to nuclear radiation of relatively high levels. It is based upon the use of TIMM (thermionic integrated micromodule) components in electronic circuits that, from a radiation standpoint, are critical circuits. Critical circuits are defined as circuits that directly influence the overall data-system accuracy. The document consists of two major sections. The first section discusses the overall system implementation, whereas the second section describes the efforts associated with the design and fabrication of a TIMM amplifier. The radiation hardening techniques are also described. Author

N64-21123 White Sands Missile Range, N. Mex. Inter-Range Instrumentation Group
IRIG STANDARD FORMAT FOR DATA TRANSMISSION
Feb. 1964 9 p
(IRIG-102-63; AD-431288)

This standard specifies a format for use in transferring trajectory-type data between ranges or between elements of a global range. The initial teletype format devised spelled-out decimal numbers for data words. Since this approach produced a capacity of only 12 samples per minute, the sexadecimal (base 16) coding was adopted. Since the sexadecimal system requires only four of the five bits available in each Baudot code character, the fifth bit has been used for insertion of transverse parity. Additionally, one character is added to each data sample for longitudinal parity, thus providing a capability for correcting one error per sample. Standard 100-word-per-minute teletype circuits can handle 20 complete samples/min; 60-word-per-minute circuits have a 12 samples/min capacity. This format is applicable to the ASA eight-level standard recently adopted, and recommended coding is given. I.v.L.

N64-21173 Navy Electronics Lab., San Diego, Calif.
PROJECT FISHBOWL EFFECTS ON OMEGA VLF TRANSMISSIONS. PHASE AND AMPLITUDE EFFECTS DURING EVENTS STARFISH, BLUEGILL TRIPLE PRIME, AND KINGFISH
C. J. Casselman, R. L. Denton, and J. J. Wilson 20 Dec. 1963 76 p
(NEL-1207; AD-435972)

The object of this investigation was to determine what effects nuclear detonations have on amplitude and phase stability of Omega signals on 10.2 kc/s and 14.2 kc/s. The Omega system uses 1-sec pulses in the very-low-frequency band and makes use of carrier-phase difference measurements. Phase and amplitude of Omega signals were studied during three events of Project Fishbowl—event Starfish (9 July 1962), event Bluegill Triple Prime (26 October 1962), and Event Kingfish (1 November 1962). Representative recordings of signals transmitted by three Omega stations, as received at 11 monitoring sites, are included. In all cases, any disturbance in propagation characteristics caused by the detonation is noted on the recording. R.T.K.

N64-21184 National Bureau of Standards, Boulder, Colo.
PERFORMANCE MEASUREMENTS ON THE FIM SERIAL NUMBER 285 FIELD INTENSITY METER Technical Note No. 6
A. H. Dove 10 Oct. 1963 74 p refs
(Contract AF 30(602)-2385)
(NBS-7970; RADC-TDR-63-186; AD-437779)

Performance measurements were conducted on the Model FIM Field Intensity Meter to determine the accuracy of the indicator circuitry and its ability to furnish realistic data on radio-frequency fields. Comparison of the FIM and the NF112 indicated that differences in the measurement of field strength were generally less than 5% when measured in a closed circuit.
Author

N64-21186 Illinois U., Urbana
THE INFLUENCE OF TRANSMISSION AND RECEPTION SETS UPON ACCEPTANCE OF ATTITUDE-DISCREPANT INFORMATION
Shel Feldman and Milton J. Rosenberg (Ohio State U.) [1964] 13 p refs
(Contract Nonr-495(24))
(TR-2; AD-431263)

A favorable attitude toward progressive education was implanted in experimental *Ss* by means of a role-playing technique. After being set either to transmit their judgments or to receive still further elucidation of the problem later on, *Ss* were given information discrepant with the implanted attitude. Their acceptance of that information was then measured. A significantly larger proportion of those with the transmission set accepted the discrepant conclusion than did those with the reception set. The reason for this result was traced to differences in the task approaches taken by transmitters and receivers, respectively. The expectation that more information was still to be received allowed employment of the defensive strategy of insulating the previously established attitude from the new, discrepant information; the use of this strategy was weakened by the necessity to transmit the available information. Author

N64-21197 Gt. Brit. Dept. of Scientific and Industrial Research, Glasgow
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE PREDICTION SERVICE, 1964 ISSUE 2
[1964] 31 p

This report contains data on: (1) 1962 Beta-Mu 2 observed during April 1963; (2) 1960 Epsilon 3, 1963-3A, 1963-27A, and 1963-30A observed during November 1963; and (3) 1960 Iota 1, 1961 Sigma 1, 1961 Alpha-Delta 1, 1962 Beta-Alpha 2, 1962 Beta-Mu 2, 1962 Beta-Chi 1, 1963-14A, 1963-30D, 1963-49A, 1964-4A, 1964-4B, and an unidentified satellite observed during February 1964. I.v.L.

N64-21211 National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
CURVES OF INPUT IMPEDANCE CHANGE DUE TO GROUND FOR DIPOLE ANTENNAS
L. E. Vogler and J. L. Noble 31 Jan. 1964 52 p refs
(Sponsored by JPL)
(NBS-MONOGRAPH-72) OTS: $0.35

Graphs of the change in input impedance of electrically short dipole antennas in the presence of an isotropic and homogeneous ground are presented, considering four types of antennas: horizontal, vertical, electric, and magnetic dipoles. Curves of the change in both the input resistance and reactance are shown for a wide range of values of the frequency, antenna height above the ground, and electromagnetic ground constants. Author

N64-21212 National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
THE NORMAL PHASE VARIATIONS OF THE 18 KC/S SIGNALS FROM NBA OBSERVED AT MAUI, HAWAII
A. H. Brady, A. C. Murphy, and D. D. Crombie 19 Mar. 1964 27 p refs
(ARPA Order 183)
(NBS-TN-206-2) OTS: $0.25

Observations of the normal phase variations of the 18 kc signals radiated from the Canal Zone and received in Maui, Hawaii are given in the form of monthly averages and standard deviations at 5-min intervals. The relations between the diurnal phase variations and the diurnal variation in the length of sunlit path are shown. The calculated mean diurnal change in effective height of reflection is 13.7 km. Values of the short-term phase differences are also given. Author

N64-21213 National Bureau of Standards, Boulder, Colo. Central Radio Propagation Lab.
AN ATLAS OF SOLAR FLARE EFFECTS OBSERVED ON LONG VLF PATHS DURING 1961
C. J. Chilton, F. K. Steele, and D. D. Crombie 13 Mar. 1964 38 p refs
(Supported by ARPA)
(NBS-TN-210) OTS: $0.30

Observations were made of three phase-stabilized VLF transmissions over four long propagation paths. The propagation paths, their respective lengths, and geographic orientations are shown. This VLF transmission network samples the variations occurring over approximately one-quarter of the earth's surface and provides an excellent means for studying the effects of solar-flare-produced ionization over a large area of the ionosphere, as well as the normal day-to-night variation in ionospheric height. Author

N64-21224 Columbia U., New York, N.Y. Electronics Research Labs.
ELECTRO-OPTICAL SIGNAL PROCESSING TECHNIQUES FOR PHASED ARRAY ANTENNAS Quarterly Progress Report P-1/199, 1 Oct.-31 Dec. 1963
A. Aimette, M. Arm, and L. Lambert 1 Jan. 1964 56 p refs
(Contract AF 49(638)-1113; ARPA Order 279)
(CU-29-64-AF-1113-ERL; AD-432977)

The research program leading to the development of a signal processor for phased array antennas by using the "time delay" and "spatial multiplexing" techniques is reviewed. A summary of the basic one-dimensional spectrum analyzer theory is presented. An electro-optical spectrum analyzer that is the major component of the phased array processor is described. An experimental model containing a single channel ultrasonic light modulator and a helium–neon gas laser light source is used to determine system performance. For a 15-mc and a 20-mc signal excitation, the theoretical resolution width of 20 kc was obtained, indicating a diffraction limited optical system. Experimental measurements of the scattered light level are also presented, indicating that a system dynamic range of 40 db is feasible. The signal simulator, transducer drivers, and the 24-channel light modulator designed for the experimental spatially multiplexed system are also described. Author

N64-21232 Bendix Corp., Baltimore, Md. Radio Div.
AN/FPS-85 SPACE TRACK RADAR Fourth Quarterly Technical Documentary Report
Griffiss AFB, N.Y., RADC, Apr. 1964 191 p
(Contract AF 30(602)-2763)
(RADC-TDR-63-494; AD-600660)

The development, fabrication, and installation of AN/FPS-85 radar are discussed. The basic system structure is described, including the machine language for the IBM-7040/7044. The monitor/operational program interface is given in detail. The monitor program specifications are divided into organization, multiprograming control, system subroutines, trap processors, and system on-line diagnosis. G.D.B.

N64-21245 Northeastern U., Boston, Mass. Communication Theory Group
[THEORETICAL STUDIES ON A SELECTED NUMBER OF FACTORS WHICH DETERMINE THE EFFICIENCY AND RELIABILITY OF COMMUNICATIONS CHANNELS] Final Report, Jun. 1, 1961-Nov. 30, 1963
Sze-hov Chang, Walter H. Lob, David C. Lai, Flavio B. Reis, Alberto R. Galmarino et al 31 Dec. 1963 86 p refs
(Contract AF 19(604)-7494; Grant AF-AFOSR-62-371)
(AFCRL-64-12; AD-600048)

Signal waveform design according to the following criteria is described: (1) orthogonality; (2) compact time support; (3) identical autocorrelation functions; and (4) specified autocorrelation functions. A scheme for improving the SNR of a PCM system and a maximum-likelihood detector for a binary channel with memory are summarized. An approximate representation of linear time-varying systems in matrix form is presented. Author

N64-21263* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE DESIGN OF PFM TELEMETRY ENCODERS
H. D. White, Jr. Washington, NASA, Jun. 1964 29 p refs
(NASA-TN-D-1672) OTS: $0.75

Pulse Frequency Modulation (PFM) is a time-division-multiplex telemetry system, especially suitable for small satellites because of its efficient use of transmitter power as a function of bit rate. The Explorer XII (Energetic Particles) satellite used a practical PFM system in which the analog-to-digital conversion was done essentially on the ground. The encoding techniques used in PFM satellite telemetry systems are described herein, with emphasis on the simplicity of synthesizing and mechanizing the encoding. Several encoders are discussed (e.g., the Explorer XII and the UK-1 encoders, and a general-purpose digital data processor). Checkout and bench-calibration techniques that facilitate integration between experiments and the encoder are included. Author

N64-21264* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE RANGE AND RANGE RATE SYSTEM AND DATA ANALYSIS FOR SYNCOM I (1963 4A)
H. W. Shaffer, W. D. Kahn, W. J. Bodin, Jr., G. C. Kronmiller, P. D. Engles et al Washington, NASA, Jun. 1964 24 p refs
(NASA-TN-D-2139) OTS: $0.75

A range and range rate system similar to the Goddard Range and Range Rate System was used to track the Syncom I through the transfer ellipse until the apogee kick motor fired. This report discusses the Syncom Range and Range Rate

System operation and the data processing. The standard deviations achieved were 15.49 m in range and 0.05 m/sec in range rate with respect to the calculated orbital elements. Analysis of the data over short continuous intervals shows the data to have an accuracy better than 20 m in range, with either the 100- or 20-kc ranging tone, and a range rate accuracy within 0.05 m/sec. Author

N64-21267* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A FLIGHT STUDY OF MANUAL BLIND LANDING PERFORMANCE USING CLOSED CIRCUIT TELEVISION DISPLAYS
Bernard R. Kibort and Fred J. Drinkwater, III Washington, NASA, May 1964 35 p refs Film Suppl. available on request (NASA-TN-D-2252) OTS: $1.00

A quantitative evaluation was made of a large number of landings in a transport airplane. Data were collected during landings with normal pilot vision, with restricted peripheral vision, and with televised view forward. Various lens focal lengths were used, and camera position was changed between nose and tail locations. Data were measured in the form of ground contact g and location of touchdown point. The results indicated that with any of the TV displays the landing quality was inferior to that with either restricted peripheral vision or normal vision; there was greater mean error in ground contact point, but little difference in ground contact g. In general, however, it was concluded that, with practice, consistently good landings can be made with this airplane when forward vision is limited to a closed-circuit TV picture if more use is made of other cockpit instrument readings than is needed for the direct forward vision landings. Author

N64-21283 Joint Publications Research Service, Washington, D.C.
A VISIT TO THE SPACE COMMUNICATIONS CENTER
N. Andreyev 3 Jun. 1964 7 p Transl. into ENGLISH from Krasnaya Zvezda (Moscow), No. 98, 25 Apr. 1964 p 6
(JPRS-24897; OTS-64-31390) OTS: $0.50

A visit to the space communications center, where signals from the stars and planets are being received, is described. This center has sensitive receivers and powerful transmitters. Even a signal that has been weakened due to the enormous distance from Mars, in hitting the mirror of the radar antenna and the sensitive receivers, gathers full force. A new receiver amplifier makes it possible to disperse the excess sound from outer space and isolate the signals from the Earth. Recently radio signals were sent to the constellations of Taurus and Cassiopeia. I.v.L.

N64-21301 Stanford U., Calif. Microwave Lab.
ELECTROMAGNETIC SHOCK WAVES IN GYROMAGNETIC MEDIA
W. B. Hatfield, Jr. Apr. 1963 201 p refs
(Contract DA-36-039-AMC-00041(E))
(ML-1020; AD-405927)

The purpose of this study was to investigate the propagation of finite amplitude electromagnetic waves in gyromagnetic media, with particular emphasis upon the formation and propagation of electromagnetic shock waves. After discussing qualitatively the nature of finite amplitude wave propagation in gyromagnetic and other media, it was found that sufficient distortion of the wave fronts leading to electromagnetic shock wave formation can occur only in waves whose characteristic frequency is far below the resonant frequency of the medium. The propagation of electromagnetic waves in the low frequency, or quasi-static, approximation was investigated using the method of characteristics; the formation of electromagnetic shock fronts was demonstrated in waves propagating parallel to the external field and to study their growth, propagation, and eventual decay. When higher-order effects are taken into account, the shock front is no longer infinitely narrow, but has a finite width, determined by a balance between the wave-steepening torque term and the wave-broadening loss term and is independent of the exchange and magnetoelastic interactions and crystalline anisotropy. Author

N64-21335 Watkins-Johnson Co., Palo Alto, Calif.
RADIO INTERFERENCE MEASURING SET AN/URM-100 (XE-1) First Quarterly Progress Report, 26 Jun.-25 Sep. 1963
William E. Budd, Robert C. Hilquist, Marshall H. Holliman, Eddie Hose, and Allan W. Shaw [1963] 84 p refs
(Contract DA-36-039-AMC-02328(E))
(W-J-63-62IR3; AD-432692)

The four major areas of concern—system concepts, microwave front-end, data-handling design, and special circuit design—have been investigated and analyzed to the point that a comprehensive design can be undertaken. The degree, speed, and type of automation consistent with a flexible test-bed model have been resolved, and several operational tests and procedures needed to overcome the limitations of practical equipment have been realized. Author

N64-21338 Gautney and Jones, Washington, D.C.
STUDY AND DEVELOPMENT OF SPECIFICATIONS FOR PROTOTYPE TRANSMITTERS AND RECEIVERS FOR FALLOUT SHELTER COMMUNICATIONS SYSTEMS Final Report
May 1964 71 p refs
(Contract OCD-PS-64-8)
(TGGM-642; AD-600065)

This report describes a study approach to the problem of developing specifications for equipment for a radio backup to a landline fallout shelter communications system. Consideration is given those aspects of shelter programs that contribute requirements for electrical performance of the equipments. Discussions are included concerning frequency availability and usage, cost analysis, technological progress, and recommendations; the report includes full specifications for three types of radio equipment. A radio backup to a landline communications system is technically feasible and cheaper. Author

N64-21396 Electromagnetic Technology Corp., Palo Alto, Calif.
FREQUENCY CONVERTER UNITS FOR L-BAND, S-BAND, C-BAND, AND X-BAND Interim Development Report No. 8, 1 Feb. 1964-29 Feb. 1964
William A. Edson et al 13 Mar. 1964 15 p
(Contract NObsr-89536)
(AD-432394)

The purpose of this project is to design and develop up and down frequency converter units between L, S, C, and X bands and a band near 35 gc. Each unit will contain a local oscillator as well as linear, passive, frequency selective elements and nonlinear solid-state elements for performing frequency conversion. A total of 40 frequency converters, 10 for each band, are to be delivered, together with data, manufacturing drawings, and a final engineering report. N.E.A.

N64-21423* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF A RANGE AND RANGE RATE SPACECRAFT TRACKING SYSTEM

E. J. Habib, G. C. Kronmiller, Jr., P. D. Engels, and H. J. Franks, Jr. Washington, NASA, Jun. 1964 59 p refs
(NASA-TN-D-2093) OTS: $1.50

A spacecraft tracking system is described that will measure range and range rate for distances varying from 150 to 400,000 km with a resolution of ±15 m in range and ±0.1 m/sec in range rate. This system will provide an order of magnitude increase in tracking accuracy and will use less power at lunar distances than present tracking methods. In addition this system is simple, transportable, and economically feasible. A preliminary portion of the system, with capability for measuring range only, has been constructed and tested by tracking an aircraft flying over the Blossom Point, Maryland, Minitrack facility; and an analysis of the results shows that the quoted accuracies and performance are feasible. Finally, several system configurations are given as they would apply to specific satellite programs. Author

N64-21424 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTERPOLATION AND COORDINATE TRANSFORMATION PROGRAM PROVIDING ACCURATE LOCAL ANTENNA POINTING FROM PREDICTED SATELLITE POSITIONS
A. K. Berndt and J. H. Berbert Washington, NASA, Jun. 1964 14 p
(NASA-TN-D-2140) OTS: $0.50

This report describes a method of producing accurate pointing information for steerable antennas by utilizing local satellite position predictions and a small on-site digital computer. The local Cartesian coordinates of the satellite are generated at Goddard Space Flight Center's Computing Center and transmitted by teletype to the various antenna sites. The on-site computer performs an interpolation and coordinate transformation, incorporates various environmental considerations, and produces a drive tape for input to the antenna directing device. This system preserves completely the accuracy of the predictions generated at the Goddard Computing Center and performs the desired operations in 0.5 real time or less. Author

N64-21425 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DETERMINATION OF MEAN ELEMENTS FOR VINTI'S SATELLITE THEORY
N. L. Bonavito Washington, NASA, Jun. 1964 65 p
(NASA-TN-D-2312) OTS: $1.75

This report presents the orbit improvement method by which mean or Izsak elements that exactly factor Vinti's two quartic polynominals are determined by comparison with observations. Also included are analytic partial derivatives for the first-order Taylor expansion of the conditional equations. Author

N64-21451 Polytechnic Inst. of Brooklyn, N.Y. Microwave Research Inst.
WAVE PROPAGATION IN SINUSOIDALLY-STRATIFIED DIELECTRIC MEDIA
T. Tamir, H. C. Wang, and A. A. Oliner 31 Jul. 1963 55 p refs
(Contract AF 19(604)-7499)
(PIBMRI-1184-63; AFCRL-63-367; AD-600715)

The dispersion properties and the fields of electromagnetic waves were investigated for propagation in a stratified infinite medium. The stratification is characterized by a dielectric constant, which, along one coordinate, was modulated sinusoidally about an average value. A systematic and comprehensive study was presented for the case of H modes for which the pertinent wave equation is in the form of a Mathieu differential equation. The modes and dispersion characteristics were analyzed in terms of a stability chart. Results were obtained for an unbounded medium, and a waveguide filled with the modulated medium; also, the reflection occurring at an interface between free space and a semi-infinite medium of this type was examined. Simple analytical expressions are obtained for all of these cases when the modulation in the dielectric is small; the fields are then expressible in terms of the fundamental and the two nearest space harmonics. The fields within a unit cell in the stratified medium were calculated for both small and large modulation and for frequencies up through the second passband; the variation of the fields is not, in general, simply related to the variation of the dielectric constant within a cell. Author

09 ELECTRONICS

Includes circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory. *For related information see*: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation and Photography; 22 Navigation and Guidance; and 25 Physics, Solid-State.

N64-20891 Lockheed Missiles and Space Co., Sunnyvale, Calif.
SLOT ANTENNA STUDIES Annotated Bibliography
George R. Evans, comp. Jan. 1963 226 p refs
(Contract NOrd-17017)
(SB-63-4; Rept. 3-80-63-1; AD-438179)

In designing guided missile antennas, a singular advantage gained from using slot antennas is that, since they are flush-mounted, drag is reduced to a minimum. References include information to aid in design and development studies. Primary areas of interest are impedance characteristics, bandwidth, and power-handling capabilities. Also included are radiation pattern analyses and waveguide studies. Many of the references, while not directly applicable to missile antennas, are included because slot theory is discussed. Author

N64-20895 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THE DESIGN AND ANALYSIS OF ELECTRICAL AND ELECTRONIC SYSTEMS BY MEANS OF DIGITAL COMPUTERS An Annotated Bibliography
Charlie M. Pierce, comp. Sep. 1963 34 p refs
(Contract NOw-63-0050-c)
(SB-63-65; Rept. 2-60-63-2; AD-439440)

Computerized methods of designing and analyzing electrical and electronics systems are being used with increasing frequency because of the demand for more complex and more efficient systems. This publication consists of 63 references dealing with the application of digital computers in this field. Most of the references were published between January 1958 and June 1963. The references are alphabetically arranged according to the first author. Indexes are included for corporate author, personal author, and subject. Author

N64-20901 North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
STUDY TO REDUCE AND COMPILE USAF NAP RADIATION EFFECTS DATA Final Report, 10 Jun. 1963-23 Mar. 1964

E. R. Beever Kirtland AFB, N. Mex., Weapons Lab., Apr. 1964 92 p
(Contract AF 29(601)-5910)
(SID-64-3; WL-TDR-64-1; AD-600054)

Irradiation tests were performed on 2,300 electronic piece parts to determine the effects of reactor-produced radiation on their operational characteristics. The irradiations were performed in a lithium hydride modified reactor environment to integrated motion fluxes greater than 10^{13} n/cm^2 (E > 0.1 Mev) and gamma doses in excess of 2×10^7 Rad (C). The vast amount of data generated in this test was reduced to approximately six pertinent data points, and recorded on computer library file cards along with information such as piece part application, manufacturer, manufacturing process, etc., concerning each electronic piece part. Author

N64-20935 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
NEW GLIDE SLOPE ANTENNAE
In its Second Intern. Aviation R&D Symp.: All-Weather Landing Systems [1963] p 89–115 (See N64-20932 14-22)

The advent of turbojet aircraft has speeded the requirement for minimizing noise and bends in the glide-slope beam to acceptable limits. The accelerated program described is aimed at realizing the full capability of 300-mc glide-slope facilities at the earliest possible date. The glide-slope facility is normally installed approximately 1,000 ft from the approach end of the runway and 500 ft to the side. An aircraft intercepts the glide slope beam at the outer marker 5.0 miles out, and proceeds downward at an angle of 3.0 degrees, passing over the middle marker 3,500 ft. from the runway threshold. Typical glide-slope sites encountered at airports are described and illustrated. It is concluded that the glide-slope antennas will provide adequate service at the majority of the sites where the following type of operation is expected: (1) flight quality and control requirements of flight to 100 ft; (2) adequate altimetry or other means for detecting 100-ft cutoff altitude; and (3) provision of appropriate weather measurements. R.T.K.

N64-20967 Rome Air Development Center, Griffiss AFB, N.Y. Research and Technology Div.
PHYSICS OF FAILURE IN ELECTRONICS, VOLUME 2
M. F. Goldberg (IIT Research Inst.) and Joseph Vaccaro, ed. [1963] 557 p refs Proc. of the 2d Ann. Symp. on the Phys. of Failure in Electron., Chicago, 25–26 Sep. 1963

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N64-20969 Battelle Memorial Inst., Columbus, Ohio
RESEARCH TOWARD A PHYSICS OF AGING OF ELECTRONIC COMPONENT PARTS
Ralph E. Thomas and H. Clay Gorton *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 25–60 refs (See N64-20967 14-09)

There are three parts to this paper: (1) a description of the general problem of accelerated testing along with the presentation of results for accelerated aging of carbon composition resistors and transistors; (2) a theoretical discussion indicating that a generalized form of the Arrhenius equation, known as the Eyring equation, may prove to be both an empirical and theoretical basis for analysis of accelerated test data; and (3) a description of experimental efforts to obtain direct confirmation of the Eyring model. A.W.

N64-20971 IIT Research Inst., Chicago, Ill.
COMPREHENSIVE FAILURE MECHANISM THEORY—METAL FILM RESISTOR BEHAVIOR
M. Goldberg, A. Horberg, R. Stewart, and D. Levinson *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 68–93 refs (See N64-20967 14-09)
(Contracts AF 30(602)-2731; AF 30(602)-3052)

These studies are concerned with the application of knowledge gained by investigations of failure physics to the problem of predicting electronic-part behavior. The approach is to construct a computerized mathematical model from physical knowledge of the part materials and of their interactions. The initial study vehicle was a metal-film resistor formed by vapor deposition of Evanohm. The material formed on the resistor substrate is richer in aluminum, chromium, and copper than the basic alloy; therefore, properties and kinetics of the basic alloy cannot be used directly in the mathematical formulations. Oxidation is one of the primary operative mechanisms in the development of the general computerized model; results of experimental studies of oxidation kinetics suggest a diffusion-limited process. Evidence of aggregation as an operating mechanism has also been obtained. A.W.

N64-20976 Sprague Electric Co., North Adams, Mass. Research Center
SOME FAILURE MECHANISMS AT INSULATOR-CONDUCTOR JUNCTIONS
G. A. Shirn and D. M. Smyth *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 154–162 refs (See N64-20967 14-09)

Anodized tantalum and ceramic barium titanate were studied to determine the detailed mechanism by which component degradation or failure occurred. The experiments indicated that degradation is due to excess oxygen vacancies. Remedial steps suggested are inhibition of the injection of vacancies, inhibition of their motion, or reduction of their number. It is not hard to go from the particular case of oxygen vacancy injection and migration to that of mass transport under the influence of electrical and chemical potentials. An insulator–electrode system should be carefully considered for this possibility. A.W.

N64-20979 General Electric Co., Philadelphia, Pa. Spacecraft Dept.
FAILURE PHYSICS AND ACCELERATED TESTING
G. Bretts, J. Kozol, and H. Lampert *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 189–207 refs (See N64-20967 14-09)

Accelerated step-stress and constant stress tests of two types of film resistors have been analyzed by means of a time-temperature parameter, based on Arrhenius-type aging mechanisms. Correlation was made with physical degradation models of the resistor types. Estimates of time to failure can be made, based on typical environmental exposures. Degradation in planar transistors was found to be affected by random discontinuities, so that a similar correlation could not be made. Author

N64-20980 Sylvania Electric Products, Inc., Woburn, Mass.
ON THE EXTRAPOLATION OF ACCELERATED STRESS CONDITIONS TO NORMAL STRESS CONDITIONS OF GERMANIUM TRANSISTORS
Jayne Partridge (MIT) *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 208–225 refs (See N64-20967 14-09)

For moisture-gettered pnp germanium mesa transistors the predominant modes of failure created during accelerated stressing are different from the predominant modes of failure created during normal stressing. During accelerated unpowered thermal stressing, parameter changes are exactly opposite to parameter changes during normal unpowered thermal stressing. The direction and irreversibility of parameter changes, the dependence of amount of parameter change on the stabilization bake temperature and internal package vapor pressure, and a good fit of h_{FE} decay to Wallmark's equation all point to oxidation of the germanium surface. The activation energy as determined from the equation is discussed. Oxidation of the germanium surface is negligible at temperatures less than stabilization bake temperatures. Author

N64-20981 Westinghouse Electric Corp., Baltimore, Md. Air Arm Div.
PREDICTION OF FUNCTIONAL ELECTRONIC BLOCK PERFORMANCE THROUGH LOCALIZATION OF MALFUNCTIONS
W. J. Lytle, J. W. Merck, J. W. Dzimianski, and S. M. Skinner *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 226–244 (See N64-20967 14-09)

Evaluation is made of test methods for indicating the presence of failure mechanisms in microelectric devices. Of nine diodes of the same type manufactured by existing solid-state microelectric technology and chosen for experiment, two were defective, but the engineers applying the contact test methods were not told of this fact. Examination was made by (1) a contact photoresponse method, and (2) a method involving determination of device characteristics at extremely low signal levels and their dependence upon the pressure applied to the probe contact. These newer techniques distinguished between the characteristics of the nine devices in a more sensitive manner than is possible with conventional measurements. They also provided more detailed information about the devices themselves and the properties of their individual components. A.W.

N64-20983 Syracuse U., N.Y.
BURST NOISE IN SEMICONDUCTOR DEVICES
W. Howard Card and Anton Mavretic *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 268–283 refs (See N64-20967 14-09)

Low-frequency excess noise comprises two components called clean noise and burst noise. Because burst noise is closely associated with chemical processes and occurs in transistors having parameter drift, a correlation between burst noise and drift is suspected. The observation that burst noise is a statistically nonstationary random process suggests a correlation with irreversible chemical processes and breakdowns. This paper has reported several systems for measuring low-frequency noise. Important features of these measuring systems are the following: (1) A strip-chart recorder is used with a broad-band amplifier and detector to distinguish clean noise from burst noise. (2) A magnetic-tape recorder used with a spectrum analyzer and an amplitude-distribution-function analyzer permit useful measurements of nonstationary processes. (3) An electronic counter permits accurate nonsubjective long-term averages of the spectrum analyzer indication. Two interpretations for burst noise are: (1) It is a nonstationary fluctuation in the level of clean noise. (2) It is the superposition of clean noise and uncorrelated voltage steps from a nonstationary process; i.e., drift in a resistance value may result from a preponderance of voltage steps (hence resistance changes) in one direction. Author

N64-20984 Shockley Transistor Corp., Palo Alto, Calif.
LOCALIZED THERMAL EFFECTS IN SILICON POWER TRANSISTORS
R. M. Scarlett and W. Schroen *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 285–303 (See N64-20967 14-09)
(Contract AF 30(602)-3016)

Effects observed in silicon power transistors are discussed and include the appearance of thermally induced breakdown and high local temperatures in a hot spot. Some studies are presented on the nature of the damage caused by the breakdown. Generally the damage results internally, in an ohmic path between emitter and collector. Continued operation in the breakdown region results in the resistance of the path becoming smaller until a short circuit is produced, accompanied by evidence of local melting. Author

N64-20985 Burroughs Corp., Paoli, Pa. Burroughs Labs.
FAILURE MECHANISMS IN SEMICONDUCTORS
H. Stuart Dodge *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 304–327 (See N64-20967 14-09)

The primary aim is to show the benefits of a comprehensive failure analysis program of semiconductor devices. Many long painstaking analyses gave answers that initially seemed obvious, but were proved otherwise by subsequent investigation. Electrical failures were emphasized, but only an estimated 35% of the total failures involving semiconductors are electrical in nature, whereas the remaining 65% are mechanical. Further, a majority of these failures occur in the initial phases of a program—during breadboarding, qualification testing, and so forth. Once a semiconductor device is in the field, operating under ideal conditions of temperature and operating range, failures are rare. Semiconductors are known to be long-life devices; some say they will last 100,000 hours (about 11 years), but this is only an estimate. Transistors have been widely used only since 1956, so that, on this basis, units in continuous use since 1956 would still have five years to go before reaching end-of-life. A realistic judgment of the lifespan of more recently developed transistors is even more difficult to obtain. Hopefully, through the expansion of techniques as described herein, prediction of end-of-life for a particular unit will be possible, and removal of a potential troublemaker before a costly failure occurs will also be possible. Author

N64-20988 Sylvania Electric Products, Inc., Mountain View, Calif.
FAILURE MECHANISMS IN TRAVELING-WAVE TUBES
R. A. Hein and J. S. Needle *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 349–360 refs (See N64-20967 14-09)
(Contract AF 30(602)-2995)

Evidence presented here provides a model for the effect of residual gases on the activity of an oxide-coated cathode. The results emphasize the concept that the total number of ions striking the emitting surface is a significant parameter that affects cathode activity. The hydrogen molecule becomes more suspect relative to cathode damage than has previously been considered. Author

N64-20996 Sprague Electric Co., North Adams, Mass. Engineering Labs.
FAILURE MODES AND MECHANISMS IN SOLID TANTALUM CAPACITORS
E. J. Fresia and J. M. Eckfeldt *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 483–497 refs (See N64-20967 14-09)

Both the catastrophic and leakage current increase failure modes are directly associated with the current flickering phenomenon peculiar to the solid tantalum capacitor. These current bursts are themselves associated with imperfections in the tantalum oxide film. Imperfections or flaws can arise from several sources, such as impurities (both metallic and gaseous) in the base metal, surface geometry of the metal, physical damage to the oxide, or thermal cycling of the metal-oxide during processing. Localized heating within microscopic flaws due to relatively high current flowing through such sites can account for leakage current rises and also for subsequent flickers, assuming an energy barrier has been exceeded that allows a sudden avalanche flow of current to occur. Occurrence of either failure mode can be reduced or eliminated by various combinations of applied voltage, environmental temperature, or circuit resistance. Author

N64-20997 Sperry Rand Corp., St. Paul, Minn. UNIVAC Div.
FAILURE MODES IN INTEGRATED AND PARTIALLY INTEGRATED MICROELECTRONIC CIRCUITS
G. P. Anderson and R. A. Erickson *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 498–524 (See N64-20967 14-09)

UNIVAC's interest in integrated semiconductor circuits is based on the obvious advantage available in size, power consumption, potential speed, and potential reliability of these devices as applied to computer application. In general, the integrated circuits display all of the proven advantages of the more common silicon planar transistors and diodes. They are manufactured by using what have become standard materials, photolithographic techniques, carrier life-time control, crystal passivation, solid-state diffusing techniques, metal depositions, etc. Also, it has not become necessary to utilize crystals having resistivities vastly different than those required for present day transistors as was the case with tunnel diodes. Failure analysis of the type discussed in this paper, along with prompt feedback of the finding to the supplier, tends to remind and harass the vendor into a continuing product improvement and surveillance effort. Failure analysis properly used can be an aid in establishing areas requiring improvement and in showing the undesirability of change in others. It can also raise the confidence in the decision regarding the use of any given device. Author

N64-20999 Naval Applied Science Lab., Brooklyn, N.Y.
FAILURE MODES IN NAVAL ELECTRONIC EQUIPMENT
J. H. Brun *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 535–549 (See N64-20967 14-09)

Major categories used in assigning cause of failure are: (1) manufacturing defect; (2) design defect; (3) misapplication; (4) associated failure; (5) miscellaneous—old age, mishandling; and (6) indeterminate. Each of these types is discussed, and examples of each are cited. A.W.

N64-21000 Syracuse U., N.Y.
IMPORTANT MECHANISM CONTRIBUTING TO TUNNEL DIODE FAILURE
R. P. Nanavati *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 550–559 refs (See N64-20967 14-09)

A simple theory for tunnel diode is presented. The predictions of the theory are consistent with the experimental observations on GaAs tunnel diodes. If the proposed theory is correct, then the following are undesirable characteristics of material for tunnel diodes: (1) direct, (2) wide band-gap, (3) high diffusivity of moving ions in the crystal, and (4) high doping levels. The theory needs further checking on tunnel diodes made from other materials. Author

N64-21016 Raytheon Co., Burlington, Mass. Microwave and Power Tube Div.
A SURVEY OF EXPERIMENTAL AND THEORETICAL WORK ON ANTENNA SYSTEMS DESIGN FOR EFFICIENT MICROWAVE POWER TRANSMISSION
Neil I. Heenan May 1964 50 p refs

The growing interest in the field of microwave power transmission revealed the need for a survey of the theoretical and experimental work applicable to this field of endeavor. Some research was recently done on the S-band, where super power tubes are available and losses in the transmission medium are low. In the millimeter region, important work was carried out by Goubau and his collaborators, and Goubau and Schwering developed a rigorous theory for the "beam modes" that propagate in a beam. The "confocal resonator" theory is reviewed, and a brief discussion is included on the problem of launching and terminating the beam correctly for efficient transfer of power. Author

N64-21042 Microwave Associates, Inc., Burlington, Mass.
BROADBAND SOLID-STATE SWITCHES Second Quarterly Report, 1 Oct.–31 Dec. 1963
R. Tenenholtz [1963] 30 p
(Contract NObsr-89463)
(AD-433094)

With respect to specific design goal characteristics, insertion loss and isolation performance offered no obstacles. However, at X-band, coax structures were used instead of waveguides, as initially conceived. A considerable amount of research remains to be done to secure operational units, including improved-performance insulated-diode mounts, and a more efficient L/S-band d.c. return. Despite this, the basic low-pass-filter switch concept proved itself valid for securing efficient broadband switch performance over the range of 1 to 11 kmc. As for power handling, results showed that close to desired peak-power handling can be obtained, particularly in the range of 1 to 4.5 kmc, where preliminary high-power tests were performed. Author

N64-21069 General Precision, Inc., Little Falls, N.J. Aerospace Research Center
ADVANCED FEEDBACK CONTROL TECHNIQUES FOR AEROSPACE VEHICLES
Bernard Friedland 15 Mar. 1963 39 p refs
(Res. Rept. 63-RC-1)

This report deals with the use of the qualitative results of optimum control theory as a guide to the rational design of suboptimal control systems that can give very good systems' performance. The suboptimum control techniques presented are: (1) linearization about a nominal optimum; (2) steepest descent; (3) the use of a flat-earth model except for the calculation of precision trajectories; and (4) optimization within a given structure. The advantages and disadvantages of each technique are discussed. I.v.L.

N64-21071 Ohio State U., Columbus Antenna Lab.
APPLICATION OF ELECTROMAGNETIC ABSORBING MATERIALS AS INTERFERENCE REDUCTION TECHNIQUES Final Report
Leon Peters, Jr., and Roger C. Rudduck Griffiss AFB, N.Y. RADC, Apr. 1964 36 p refs
(Contract AF 30(602)-2711)
(RADC-TDR-63-549; AD-600652)

Means of controlling undesired radiation of antennas for reduction of radiofrequency interference are given for the horn, the parabola, and the Luneberg lens antennas. The radiation mechanisms of each antenna are obtained and used as a guide line for this reduction. A new approach for finding the diffraction by thick edges was developed and was used to determine the radiation patterns of horn antennas. Back radiation for the horn may be reduced by reducing the energy incident on these edges. Choke joints were used for this purpose, and were proposed as a method for increasing the effectiveness of shielding screens. A method is given for creating nulls in the Fresnel zone of an antenna by using a small amount of absorber material. Author

N64-21074 Ohio State U. Research Foundation, Columbus
HIGH GAIN ANTENNA REALIZATION AND TRACKING STUDY Final Report, 1 Nov. 1962–31 Oct. 1963

Jon W. Eberle, S. L. Zolnay, C. H. Brenner, W. H. Peake, and D. C. Merchant Griffiss AFB, N.Y., RADC, Apr. 1964 173 p refs
(Contract AF 30(602)-2166)
(Rept.-1072; RADC-TDR-64-72; AD-600651)

The purpose of the research is to develop and optimize a technique for achieving high antenna gain for coherent communications without the inherent inflexibility of a single, large-aperture antenna. An array of four 30-ft-diameter parabolic elements and associated combining and control equipment was designed and built. The work in the past contract year was a complete shakedown and alignment of the array, a definition of the experiments to be performed, and the data to be recorded for each experiment. The data-reduction equipment was also installed, calibrated, and checked out for proper operation. A study was made on possible uses of an array of high-gain elements for scientific purposes. Various methods of pattern control and an approach to a signal-processing antenna were studied. In addition, a photogrammetric method of measuring the surface contour of a parabolic antenna in operating position was developed. The technique was used to measure one of the array elements, and yielded an accuracy of 2 mm. Author

N64-21104 Harry Diamond Labs., Washington, D.C.
TRANSISTOR FLIP-FLOP AND RING COUNTER WITH NON-VOLATILE MEMORY
Ira R. Marcus 5 Feb. 1964 19 p ref
(TR-1198; AD-439223)

A modification of the standard transistor flip-flop and ring-counter circuits was made; it allows setting information to be inserted by an electrical pulse. The supply voltage is not applied to the stages during the insertion of the setting information. When the supply voltage is applied, the flip-flop and ring-counter stages assume the desired state. In addition, if during normal operation the supply voltage is interrupted and reapplied, the stages will return to the state they were in before interruption. These features are incorporated into the flip-flop and ring-counter circuits with the addition of one square-loop magnetic core per stage. Author

N64-21108 Polytechnic Inst. of Brooklyn, N.Y. Microwave Research Inst.
EQUIRIPPLE TRANSMISSION LINE NETWORKS
Werner Kohler and Herbert J. Carlin 24 Jan. 1963 92 p
(Contract AF 30(602)-2213)
(PIBMRI-1089-62; RADC-TDR-62-629; AD-297373)

The synthesis of microwave broadband equalizers, comprised solely of a cascade of lossless equilength transmission lines operating between a resistive generator and a resistive load, has been thoroughly established. For this class of network, equiripple response specification is accomplished through recourse to techniques employed in the analogous low-pass lumped-parameter case. The d.c. point, at which the lines become transparent, makes it possible to readily prescribe the value of the load resistance. This thesis considers the case in which the aforementioned cascade configuration is augmented by the presence of lossless transmission line stubs, having lengths commensurate with those of the lines. Chebyshev-type response specification is developed for specific types of this generic class, which, because of the stubs, possess finite ω-frequency zeros of transmission. The last segment of the thesis is devoted to the design of a reflection-type tunnel diode amplifier, utilizing a transmission line equalizer. The diode parasitics are approximated in the frequency band of interest by transmission line stubs. This approximation circumvents the problem of transcendental functions inherent in lumped reactance-transmission line mixtures and enables the adaptation of the above-mentioned equiripple response functions by an extension of the Fano theory of broadbanding. Author

N64-21120 General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science
THE FABRICATION TECHNIQUE AND SPECTRAL CHARACTERISTICS OF A SPECIAL-PURPOSE ULTRAVIOLET PHOTODIODE
R. E. Rinehart 14 Feb. 1964 13 p refs
(Contract AF 29(601)-6214)
(GA-4611; AD-431255)

A small, rugged photodiode that responds only to ultraviolet light of wavelength less than 3,050 A was developed, fabricated, and used in ablation experiments. The development and fabrication of the photodiode are described, and its spectral characteristics are summarized. R.T.K.

N64-21148 Lockheed Missiles and Space Co., Sunnyvale, Calif.
PRINTED CIRCUITS AND WELDED MODULES [1963]: AN ANNOTATED BIBLIOGRAPHY
Jack B. Goldmann comp. Dec. 1963 45 p refs
(Contract AF 04(647)-673)
(SB-64-2; Rept. 3-35-64-2; AD-600708)

This bibliography is a continuation of SB 63-17, "Printed Circuits and Welded Modules: An Annotated Bibliography (1962)." Microminiaturization of circuits and components as it is applied to manufacturing research, design standards, and procedures; production methods and techniques and applications of the fabricated items were the subjects for which information was sought. Author

N64-21150 Polytechnic Inst. of Brooklyn, N.Y. Microwave Research Inst.
FIVE-REACTANCE BROADBAND COMPENSATION DESIGNS
Bernard Michael Albrecht, Jr. Jun. 1964 37 p refs
(Contract AF AFOSR-453-63)
(PIBMRI-1218-64; AD-600449)

The most detrimental factor to the high-frequency response of an amplifier is the total parasitic capacitance that shunts the output terminals. In particular, this shunt capacitance causes serious distortion to the step response and the amplitude response of the amplifier. Nevertheless, considerable improvement of the high frequency response can be achieved by the addition of a filter to the output terminals. The design of such a filter has five reactive elements, and a constant voltage source with a finite internal impedance. The criteria for design are twofold: critically damped transient response and maximally flat amplitude response. The results of each design are compared graphically with an uncompensated reference obtained by letting each compensation element go to zero. These curves are indicated by the letter U. Also included in the results are the pole-zero plots of the transfer functions of each design. Finally, all figures are rounded off to four places and tabulated. Author

N64-21176 Raytheon Co., Waltham, Mass. Research Div.
HIGH FREQUENCY TUNNEL DEVICE STUDY
S. R. Steele and A. Starr N.Y., Griffiss AFB, RADC, Apr. 1964 47 p refs
(Contract AF 30(602)-3249)
(RADC-TDR-64-116; AD-600589)

The work reported here is aimed at investigating the feasibility of achieving low-noise microwave amplification by using tunneling. The experimental work done consisted primarily of: (1) fabrication of tunnel cathodes; (2) investigation of the life

and stability of these devices in continuous operation under both d.c. and a.c. conditions; and (3) investigations of the low-noise properties of the tunnel cathode involving d.c. measurements near the threshold of emission. Author

N64-21238 Northwestern U., Evanston, Ill. Information-Processing and Control Systems Lab.
DISTANCE MATRIX AND THE SYNTHESIS OF N-PORT RESISTIVE NETWORKS Technical Report No. 5
S. L. Hakimi and S. S. Yau 1 Oct. 1963 38 p refs
(Grant DA-ARO(D)-31-124-G223; AF-AFOSR-98-63)
(AROD-3298-9; AD-438496)

This paper is concerned with two interrelated problems: (1) a study of distances in a linear graph, and (2) the synthesis of n-port resistive networks. The distances in a linear graph are described by a distance matrix, D. The realizability of D as a linear graph is considered. The conditions under which the realization of D is unique are described, and the optimum realization of D is investigated. The problem of the synthesis of n-port resistive networks is then attacked by showing that the open-circuit impedance matrix Z_{oc} of an n-port grounded resistive network can be transformed into a distance matrix. A method for arriving at a circuitless realization Z_{oc} (if such a realization is possible) is presented. Author

N64-21296 Union Carbide Corp., Parma, Ohio Linde Div.
DEVELOPMENT OF THIN ORGANIC ROLLED FILM CAPACITOR Third Quarterly Progress Report, Jan. 1-Mar. 31, 1964
D. J. Valley [1964] 66 p
(Contract NObsr-89519)
(AD-600317)

Work is reported on a program designed to develop a capacitor, using an ML-1 film as the dielectric, capable of 100-v operation over the temperature range of −55° to 170° C. The capacitor is to exhibit dissipation of 0.01%; insulation resistance of at least 15 ohm farads at 170° C; temperature coefficient of less than 250 ppm/°C; 250% dielectric withstanding voltage; no capacitance shift with frequency; less than 5% change in capacitance after life test. Discussed are: (1) foils; (2) coated foils; (3) slitting; (4) metallized-type ML-1 film capacitor; (5) special processing; (6) sample capacitors; and (6) life test. Included is a tabulated test summary. N.E.A.

N64-21313 Radio Corp. of America, Camden, N.J. Communications Systems Div.
LOW COST ARMY MICROMODULE PROGRAM Second Quarterly Report, 1 Oct.-31 Dec. 1963
P. Margolin [1963] 40 p
(Contract DA-36-039-AMC-03259(E))
(AD-439238)

The selected functional assembly of MICRORAC, the timing level generator, was analyzed, and four module types were developed to satisfy its requirements. Of three candidates, Fairchild Micrologic II logic elements were selected over Motorola MECL and Signetics. Six different Fairchild logic elements were used. A new design module structure called a 28/20-Module assembly was chosen. This module resembles the standard RCA micromodule but has 28 riser wires of which 20 are brought out to serve as plug-in pins. The modules contain either 2, 3, or 4 ICP's and 1 interconnection wafer. A new integrated circuit package (ICP) having 14 leads was developed as a compatible unit for assembly into the new module. Each terminal of the ICP connects with an alternate riser wire of the module. Design rules are established for allocating pin functions in the 28/20 module, the ICP's, and for employing intra-module riser wire interconnection wafers. Two interconnection wafer types satisfy the requirements of the four module types. Author

N64-21318 Eitel-McCullough, Inc., San Carlos, Calif.
HIGH POWER X-BAND GENERATOR Quarterly Report No. 5, 1 Oct.-31 Dec. 1963
William R. Luebke, Jared Leidigh, and Tore Wessel-Berg 12 Feb. 1964 42 p refs
(Contract AF 30(602)-2756)
(RADC-TDR-64-77; AD-600019)

The purpose of this program is to develop a klystron amplifier operating at 8 kmc and delivering 1 mw of cw power. In this report, test results are presented on a second low average power pulsed tube having an extended-interaction output cavity. Further development work on the output cavity is discussed. An interim tube designed to be capable of more than a 100 kw of average power was constructed, and is being prepared for testing. The lossy waveguide water loads are briefly described. A theoretical analysis and discussion of the mode overlapping problem in extended-interaction circuits is presented. Author

N64-21325 General Electric Co., Irmo, S.C.
HERMETICALLY SEALED ELECTROLYTIC CAPACITOR Final Report, 15 May 1962-15 Nov. 1963
R. M. Trewhella [1963] 59 p
(Contract DA-36-039-SC-89093)
(AD-430355)

The ability to develop, design, and fabricate a true or single hermetically sealed tantalum-foil, electrolytic capacitor for operation in outer space has been demonstrated, by the successful performance of the final development of a hermetically sealed capacitor evaluated in accordance with the Signal Corps Test Plan SCL-6417. The compatibility of the materials used in the final design has been further demonstrated in prototype units that have successfully completed 12,000 hours on test at 85° C with rate voltage applied. This new packaging approach further advances the state-of-the-art for tantalum-foil electrolytic capacitors. J.L.D.

N64-21327 Teledyne Systems Corp., Hawthorne, Calif.
UNFURLABLE ANTENNA TECHNIQUES FOR HIGH-GAIN APPLICATIONS Interim Engineering Report No. 1, 1 Jun.-17 Dec. 1962
J. C. Polk 1 Feb. 1963 39 p
(Contract AF 33(657)-8709)
(TSC-63-ESD-19; AD-297469)

The design of a high-gain Cassegrain system with a spherical reflector is discussed. The effects of aperture blocking are analyzed, and calculated patterns are given that show these effects. Equations for the subreflector surface are given, and calculated surfaces are plotted for different locations of the feed and the subreflector. Also discussed is the design of an unfurlable, four-element system that will radiate four 60° beams, located with axes 60° apart, to cover a 120° sector in two orthogonal planes. Conical spiral elements were designed and tested and found to be satisfactory. Mutual coupling effects were measured and found to be negligible. Author

N64-21332 Microwave Electronics Corp., Palo Alto, Calif.
DEVELOPMENT OF PPM-FOCUSED LOW-NOISE TRAVELING-WAVE TUBES FOR K_u AND K_a-BAND Interim Development Report No. 2, 1 Oct.-31 Dec. 1963

Feb. 1964 23 p
(Contract NObsr-89323)
(MEC-QTR-NObsr-89323-2; AD-432237)

Eleven K_u-band low-noise tubes were built and RF tested. The design was changed to minimize noise and to reduce phase velocity dispersion by the helix. Three K-band low-noise tubes were built and tested, and low noise and high dispersion were found. Plans were made to reduce the beam dispersion by redesigning the tubes. Two K_a-band low-noise tubes were built with components designed to minimize noise and dispersion; these tubes are ready for testing. D.E.W.

N64-21333 Ohio State U. Research Foundation, Columbus Antenna Lab.
INVESTIGATION OF RESEARCH ON TECHNIQUES FOR INTEGRATION OF ACTIVE ELEMENTS INTO ANTENNAS AND ANTENNA STRUCTURE Interim Engineering Report, 1 Dec. 1963-29 Feb. 1964
1 Mar. 1964 15 p ref
(Contract AF 33(657)-10386)
(Rept.-1566-9; AD-600105)

Circuitry for an elementary direction-finding system, using integrated design concepts, is discussed. Preliminary measurements indicate that good performance of the amplitude and phase-shift beam-control array may be expected because of the good agreement between calculated and measured amplitude and phase-shift performance of the individual dipole antennafier elements. The elementary direction-finding and homing system is nearly completed. Based upon the simulated antenna patterns, it is estimated that the completed system will provide reasonably accurate directional information in a 45° cone surrounding the system's symmetry axis, and should yield useful information in an approximately 90° cone. J.L.D.

N64-21334 Sperry Gyroscope Co., Great Neck, N.Y. Electronic Tube Div.
DEVELOPMENT OF AN ELECTRON BEAM DUPLEXER Third Quarterly Progress Report, 1 Sep.-30 Nov. 1963
B. Kleinman and E. Hine Dec. 1963 19 p refs
(Contract DA-36-039-AMC-02174(E))
(NA-8210-8352-3; AD-432292)

The first S-band tube was tested for its high power performance, and design changes were made to improve this characteristic. A new coaxial coupler was developed that gave substantial improvement in the match to the helix. Tube No. 2, incorporating the changes dictated by the tests performed on the first tube, was built and awaits processing and testing. Author

N64-21337 George Washington U., Washington, D.C. Human Resources Research Office
IMPLEMENTATION AND CHECKOUT OF THE FORECAST CONCEPT OF ELECTRONIC SYSTEM REPAIR AT THE U.S. ARMY ORDNANCE GUIDED MISSILE SCHOOL
Edgar L. Shiver, C. Dennis Fink, and Robert C. Trexler Aug. 1963 76 p refs
(Contract DA-44-188-ARO-2)
(HumRRO-TR-83; AD-438010)

Task FORECAST is concerned with the maintenance of electronic systems, and within that area, the focus is on the troubleshooting processes. This report first discusses the FORECAST concept; then it describes, in turn, its implementation by the Ordnance Guided Missile School (OGMS) personnel, the nature of the course materials produced, and, finally, the evaluation of the course by students and observers. The last section includes implications and a discussion of possible future directions for research and implementation. N.E.A.

N64-21343 General Time Corp., Stamford, Conn. Central Research Lab.
INTERIM ENGINEERING REPORT FOR AN ELECTRO-MECHANICAL STEPPER, 8 DEC. 1963-7 MAR. 1964
7 Mar. 1964 33 p
(Contract NObsr-89384)
(AD-431978)

Development, fabrication, and sample production of an electromechanical stepper to remotely actuate electromechanical devices (i.e., rotary selector switch assemblies) are discussed. The finished solenoids have the following characteristics: (1) They can withstand without damage a dielectric test of 1,000 v rms at commercial frequency applied for a period of 1 min between the coil terminals and the case. (2) With an application of maximum operating voltage to the coil, the temperature rise of the coil does not exceed 85° C. (3) The solenoid does not produce a magnetic field greater than the field produced by a straight bus bar carrying a direct current of 15 times the coil current of the solenoid. P.V.E.

N64-21356 Systems Research Labs., Inc., Dayton, Ohio
INVESTIGATION OF SECONDARY PHENOMENA FOR USE IN CHECKOUT [Final Report, Oct. 1962-Jan. 1964]
Gilbert S. H. Hwang Wright-Patterson AFB, Ohio, Aero Propulsion Lab., Jan. 1964 136 p refs
(Contract AF 33(657)-9913)
(SRL-491-TDR-1; APL-TDR-64-4; AD-431821)

This report discusses the experimental work, results, and conclusions of the investigation of secondary phenomena for use in checkout of electronic components and circuitry. It consists of a literature survey of the various secondary phenomena generated by operating electronic circuits and the methods of sensing them without direct electrical contact with these circuits. The investigation of physical laws and phenomena, from which suitable subjects for further consideration were selected, was also part of this program. Different detection techniques of various secondary phenomena were tested experimentally: these were X-ray absorption, infrared using a thermistor, infrared using fluorescence, radiofrequency emission, magnetic fields, and electric fields. At present the X-ray absorption, infrared, and radiofrequency emission show the most promise for future consideration, although these systems will require additional time and effort to develop the techniques and necessary instrumentation. Author

N64-21364 Michigan U., Ann Arbor Cooley Electronics Lab.
STUDY AND INVESTIGATION OF A UHF-VHF ANTENNA Bimonthly Report No. 6, Nov. 2, 1963-Jan. 2, 1964
J. E. Herman and S. B. Rhee Mar. 1964 58 p
(Contract AF 33(657)-10607)
(Rept.-5549-6-P; AD-600116)

Design criteria for optimal use of ferrites in rectangular slot radiators have been established. Analysis firmly indicates that similar optimization can be achieved for annular slot antennas. Further experiments with log conical spirals have been performed that resulted in extension of frequency range. A log conical antenna taking full advantage of the frequency range of the available ferrite powder has been made. An analytical study of the equiangular spiral that can be adapted to the introduction of layers of ferrite has been completed. Preliminary test data on a log zigzag antenna using powdered ferrite are presented. Author

N64-21371 Litton Industries, San Carlos, Calif. Electron Tube Div.
RESEARCH ON NOISE IN CROSSED FIELD GUNS Quarterly Report No. 2, 1 Oct.-31 Dec. 1963

R. P. Wadhwa 20 Jan. 1964 52 p refs
(Contract NObsr-89546)
(AD-431248)

The sole coupling mechanism in an injected-beam crossed-field amplifier is discussed, and some means to reduce this coupling are described. Sole coupling is one of the main criteria for establishing the stability of the device. Cold test measurements are described. The equations needed for noise figure calculations are derived, and some results on the three waves excitation are given. Some further considerations in reducing the value of the diocotron gain are discussed, and application of these studies in reduction of the noise figure is discussed. Some initial work toward cyclotron wave interaction is described. Author

N64-21384 Di/An Controls, Inc., Boston, Mass.
MAGNETIC LOGIC IN SPACE (A REPORT OF APPLICATIONS AND RELIABILITY)
Jan. 1964 38 p refs

Magnetic-core transistor logic elements are described in detail. Characteristics such as power consumption, final cost, simplicity, and individual and system reliability are discussed. Effective reliability statistics are discussed, and it is asserted that: (1) component-failure statistics are of doubtful value in quantitatively estimating system reliability; and (2) component-assembly statistics can provide accurate system-reliability estimates. The reliability and performance record of magnetic-core transistor logic elements is reviewed, with attention being given to quality assurance, dominant failure modes, life tests, field data, and radiation tests. The present and potential roles of magnetic logic in aerospace programs are discussed, and appendices on circuit operation, logic notation, and high "logic power" are included. D.E.W.

N64-21387 Westinghouse Electric Corp., Baltimore, Md. Electronic Tube Div.
DEVELOPMENT OF THE MIRRECHON SIGNAL STORAGE TUBE Quarterly Report No. 3, Nov. 1963-Jan. 1964
A. S. Jensen, M. P. Siedband, E. F. Wood, and R. A. Yeates [1964] 13 p
(Contract NObsr-89303)
(AD-432225)

The general configuration of the Mirrechon will consist of the storage target assembly, the main electron-optical lens, and the gun-multiplier assembly. Experiments on target making are being continued; development of new lens has begun; spiral type lenses have been made and tested; and the first sealed-off tube was completed. N.E.A.

N64-21399 Sylvania Electric Products, Inc., Williamsville, N.Y. Central Engineering Labs.
V-BAND HARMONIC GENERATOR DEVELOPMENT PROGRAM Final Report
3 Dec. 1963 43 p refs
(Contract DA-30-069-ORD-3705)
(A-103-004-5.0-56; AD-432665)

This report documents the findings of a program designed to develop and fabricate an all-solid-state V-band harmonic generator with a CW power output of 3 mw at 68 Gc. An objective of the program was the delivery of an X-band multiplier unit with two alternate drivers. The first driver was to be a Klystron unit with an accompanying power supply; the second an all-solid-state unit operating only on d.c. input power. The following developments were discussed: (1) X- to V-band multiplier; (2) X- to K_μ-band multiplier; (3) K_μ- to V-band multiplier; (4) mixer crystal; (5) d.c. to X-band multiplier; and (6) power supply and Klystron. It was concluded that all solid-state harmonic generators in the 50- to 70-Gc region are definitely feasible, and the successful operation of a completely solid-state local oscillator and mixer combination has been demonstrated at 68.5 Gc. N.E.A.

N64-21401 Northern Electric Co., LTD., Ottawa (Canada) Research and Development Labs.
DEVELOPMENT OF MICROMINIATURE SOLID STATE CIRCUITS Progress Report No. 2, 1 Aug. 1963-1 Feb. 1964
J. Y. Perron [1964] 42 p refs
(Contract DRB-300007)

The purpose of this program is to investigate processes and techniques for the manufacture of microminiature semiconductor circuits for use in equipment such as airborne equipment, compact logic circuits in computers, and portable instruments. The current status includes the following: (1) Changes in circuit layout were made to reduce the values of the two large capacitors from 0.1μf to 0.05μf and to rearrange the contacts to enable interconnections without crossover. (2) Changes in processing technique were required to improve the yield and accuracy of the capacitors produced. Capacitor yield is now approximately 46% giving a circuit yield of approximately 20%. Some difficulty has been encountered in maintaining the accuracy of capacitors to ±2% of the nominal value. (3) The use of a platinum film over the gold improved the solderability of contacts. (4) Tests have been conducted on the use of primers to provide adhesion of the silicone to the glass and to possible container materials such as polyvinyl chloride, polypropylene, and aluminum. (5) A number of wafers containing the integrated NOR circuit have been fabricated and tested. The transistors leaked. I.v.L.

N64-21415 Michigan U., Ann Arbor Cooley Electronics Lab.
STUDY AND INVESTIGATION OF A UHF-VHF ANTENNA Bimonthly Report No. 8, Mar. 3, 1964-May 2, 1964
J. E. Herman, S. B. Rhee, A. I. Simanyi, and D. E. Oliver May 1964 14 p
(Contract AF 33(657)-10607)
(Rept.-5549-9-P; AD-600557)

Extensions of the rectangular slot which was filled with ferrite and was cavity backed, were made. Experiments were performed in replacing certain rectangular prismatic regions with balsa wood in place of ferrite. The ensuing effects upon VSWR and radiation patterns were observed and reported. In addition, numerous experiments were performed using a log conical spiral backed by an aluminum cylindrical cavity. Ferrite was placed in numerous locations, and data were recorded for a variety of arrangements that yielded promising but tentative results. Author

N64-21419* Thompson Ramo Wooldridge, Inc., Cleveland, Ohio
OPTIMIZATION STUDY OF HIGH POWER STATIC INVERTERS AND CONVERTERS First Quarterly Report, 1 Aug. 1963-31 Oct. 1963
Arthur B. Larsen and James E. Murray Washington, NASA. May 1964 149 p refs
(Contract NAS3-2785)
(NASA-CR-42) OTS: $2.75

A general description of the operation, limitations, and advantages of many presently known transistor and silicon-controlled rectifier inverter circuits is included. These include the unidirectional and bidirectional series inverters, the simple (Wagner) parallel inverter, as well as the more involved McMurray–Bedford and McMurray parallel inverters. Techniques for voltage regulation before, in, and after the main inversion stage

are described. Harmonic reduction by several methods, including stepped wave synthesis, filtering, and high-frequency pulse techniques, is discussed. The bidirectional series (SCR) inverter and McMurray–Bedford parallel (SCR) inverter are analyzed in detail. Initial studies of the problems of inverter operation at 3,200 cps 10 kva are included. Author

N64-21446 Hughes Aircraft Co., Fullerton, Calif. Ground System Group
PRELIMINARY DESIGN STUDY OF A FLAT PLATE REFLECTOR AND SUPPORT UNIT Final Report, 15 May 1963-14 Jan. 1964
Allen C. Schell 8 May 1964 205 p ref
(Contract AF 19(628)-2994)
(FR-64-14-69; AFCRL-64-285; AD-600046)

The multiplate technique is a method of obtaining large-aperture antennas at a low cost per unit area. The technique is to divide the total area into subunits so that the entire cost of the antenna is minimized. The aperture tolerances were held small by mounting each unit on the earth, rather than on a raised structural support. Flat plates are used as reflecting surfaces that redirect the incident energy to the focal area. These plates are arranged in a desired pattern around a feed tower on fairly flat ground. The use of a flat base for the plates compels narrow-band operation for fixed settings, but the adjustability of the plates permits operation over a wide frequency range and rapid and flexible beam-steering. Each plate must be capable of independent adjustment in height and orientation to provide wide frequency and angular coverage. Each plate is controlled by a plate-positioning apparatus that allows the beam to be moved from any position to any other within a 90° cone centered on zenith within 13.4 seconds. Instructions to the plate positioners are provided by a central computing unit that is used both to set the plates and to process the data gathered. Author

N64-21454 Hughes Aircraft Co., Culver City, Calif.
INFORMATION THEORETIC EVALUATION AND OPTIMIZATION OF ANTENNA SYSTEMS Scientific Report No. 2
G. O. Young and A. Ksienski Mar. 1964 133 p refs
(Contract AF 19(628)-333)
(AD-600479)

The need for statistical analysis and optimization in antenna systems is discussed. Whereas current radar system design and optimization techniques employ statistical techniques and evaluation criteria extensively, this type of radar analysis generally stops at the antenna terminals. The antenna and microwave equipment back of the antenna terminals is still designed by classical techniques without the use of statistical criteria, tending to produce a mismatch at the antenna terminals, undesirable from the point of view of both the system designer and the antenna designer. To eliminate this difficulty, the antenna should be included as part of the overall system to be optimized, accomplished by extending statistical concepts from the temporal domain into the space–time domain. Two statistical criteria are developed and their application illustrated by examples. The first criterion is the maximization of (space–time) information content and rate. The second criterion is the minimization of information content and rate in the error (deviation between desired and actual output). Author

N64-21457 Lincoln Lab., Mass. Inst. of Tech., Lexington
THE DIAMOND CIRCUIT
R. H. Baker, R. E. Mc Mahon, and R. G. Burgess 30 Jan. 1963 32 p
(Contract AF 19(628)-500)
(MIT-TR-300; AD-400955)

A transistor bridge network is described, and the utilization of the basic circuit and several of its derivatives in the design of data-processing systems is illustrated. Network derivations are given in order to show the relation of accuracy, speed, and power consumption. Author

N64-21459 General Telephone and Electronics Labs., Inc., Bayside, N.Y.
STUDY OF FAILURE MECHANISMS IN HIGH-POWER RADIO FREQUENCY GENERATING DEVICES Technical Documentary Report, 30 Oct. 1963-29 Jan. 1964
M. Friedman Axler and R. A. Hein Griffiss AFB, N.Y., RADC, Apr. 1964 20 p
(Contract AF 30(602)-3018)
(RADC-TDR-64-107; AD-600522)

The aim of this investigation is to determine failure mechanisms caused by residual gases in traveling-wave tubes and to study means of eliminating these gases in order to improve tube reliability. Medium-power X-band amplifiers have been life tested at a high duty factor and evaluated against tubes tested at a lower duty factor; a change in tube processing appears to improve tube performance. Initial electrical and gas data are reported for other tube types. Gas ambient and sorption phenomena for oxide-coated cathode–anode subassemblies under operating conditions are presented. Application of the anode accelerating voltage causes desorption of hydrogen and hydrogenous gases; thus, the anode is a major source of hydrogen. Author

N64-21469 Clevite Corp., Bedford, Ohio Piezoelectric Div.
PRODUCTION ENGINEERING MEASURE FOR CERAMIC FILTERS Quarterly Report, 30 Dec. 1963-29 Mar. 1964
A. Lungo [1964] 32 p
(Contract DA-36-039-AMC-01471(E))
(Rept.-4; AD-600382)

Preliminary vibration tests were performed on a 1.75-mc filter. The results are discussed. A micromodule package design was completed. Difficulty encountered in meeting the volumetric requirement of the contract is discussed. Attempts to eliminate the spurious resonances in the 6.0-mc resonators were not successful. The ring electroding and spurious resonance problems encountered have delayed several phases of the contract. An investigation of these problems was initiated, which is described and discussed. Requiring ring electrodes, the 4.3-mc resonators are included in the investigation. Author

10 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations. *For related information see:* 06 Auxiliary Systems.

N64-20775 Texas Western College, El Paso Schellenger Research Labs.
ESTABLISHMENT OF A METEOROLOGICAL ROCKET STATION AT McMURDO, ANTARCTICA
Ralph A. Rotolante, Raymond S. Briggs, and James F. Bettle Oct. 1963 58 p refs
(Grant NSF G-19284)

The problems encountered during the establishment of a meteorological rocket site at McMurdo, Antarctica, are discussed. Research methods and procedures are detailed; the equipment used is described. The temperature and wind profiles obtained during the first series of rocket firings are included. Author

N64-20810 Federal Aviation Agency, Washington, D.C. Library Services Div.
AIRPORTS AND HELIPORTS: DESIGN, CONSTRUCTION AND MAINTENANCE. SELECTED REFERENCES Bibliographic List No. 9 [1959 to Date]
Jul. 1963 74 p refs
This bibliography on "Airports and Heliports: Design, Construction, and Maintenance" is a partially annotated compilation of selected references with international coverage from 1959 to date. I.v.L.

N64-20863 Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.
DEVELOPMENT AND TEST OF A LABORATORY SYSTEM FOR SIMULATION OF AERODYNAMIC AND RADIATIVE COOLING OF STRUCTURES Technical Documentary Report, 20 Jun. 1962-20 Aug. 1963
R. B. Anderson et al Wright-Patterson AFB, Ohio, Res. and Technol. Div., Apr. 1964 193 p refs
(Contract AF 33(657)-8670)
(RTD-TDR-63-4235; AD-600155)
The report summarizes criteria that establish the requirements of the system, presents data and analyses on the most practical methods of implementing the system, shows the detail design features of a prototype system, and includes the results of a test program to insure the performance and workability of a system that will be compatible with, and form an integral part of, the existing radiant heat facility. The cooling system consists of high-pressure airstreams directed onto test structures and acting in conjunction with radiant heat from quartz heat lamps to provide controlled cooling at test temperatures up to 3,000° F. A unique liquid "injection" system provides for the high cooling rates of up to 20 Btu/sec-ft^2. The entire system operates automatically, utilizing the existing function generation, thermal controller, and thermocouple feedback equipment to full advantage. Author

N64-20896 Lockheed Missiles and Space Co., Sunnyvale, Calif.
TUBE AND SEA LAUNCH DYNAMICS Annotated Bibliography
Peter R. Stromer, comp. Sep. 1963 19 p refs
(Contract AF 04(694)-418)
(SB-63-67; Rept. 4-24-63-1; AD-438183)
Publications concerned with tube and sea launching are given in this bibliography. With a trend toward larger missiles, rockets, and launch sites, ways for other methods of launching payload vehicles into space were explored. Sea launching offered attractive possibilities of greater mobility, elimination of costly ground support equipment, and reduced hazards. The booster, with or without staging, can be floated vertically on the surface of the ocean and launched from this position. The concept of tube or silo launching has already demonstrated its feasibility and this method is now operational. References to these launching techniques and other more exotic schemes employing vacuum air boost or nuclear-powered cannon for initial thrust velocity are included. Author

N64-21013 Federal Aviation Agency, Atlantic City, N.J. Evaluation Div.
EVALUATION OF TAXIWAY CENTERLINE LIGHTING Final Report
Robert F. Gates Mar. 1964 82 p
(RD-64-46)
A project was undertaken to determine the suitability of taxiway centerline lighting toward establishing new configuration and design criteria for airport taxiway lighting. The report reviews the taxiing problem during low-visibility conditions. In accomplishing the project, comparisons were made among the standard blue taxiway edge lighting, taxiway edge reflective markers, and taxiway centerline lighting. Adequacy of new fixtures, 180-cycle regulators, and a control system for taxiway centerline lighting were also evaluated. A specially prepared Mylar film was used in simulating taxiway centerline light visibilities (TCLV) of 1500, 600, and 200 ft on straight and curved taxiways of differing radii. Photometric and environmental tests were conducted over a period of approximately a year and a half on four types of fixtures. It was concluded that taxiway centerline lighting was a significant improvement over conventional edge lighting and that aircraft could accurately taxi in visibilities as low as 200 ft over a taxiway centerline lighting system. Author

N64-21216 International Electric Corp., Paramus, N.J.
STRATEGIC AIR COMMAND CONTROL SYSTEM (465L) Monthly Test Progress Report, 21 Nov.-20 Dec. 1963
Bedford, Mass., L. G. Hanscom Field, ESD, 20 Jan. 1964 94 p refs
(Contract AF 19(626)-8)
(ESD-TDR-64-197; AD-433211)
Information is presented concerning each Milestone established in the 465L System Test Plan. The Milestone information is organized generically by Centrals and descriptive titles for other activities of similar scope. These, in turn, are consolidated according to subsystem and comparable collective designations. Testing not attributable to the 465L System Test Plan Milestones System Test Facility (STF) supported demonstrations, special tests, and training. Operational information and test data obtained at the STF were used in planning and development of the 465L System. Specific activities reported included testing of applicator heads for the Quadrajector, and investigation of buffer fail indications and loss of addresses (at the EDLCC) on AXC printouts. Test activities conducted in connection with the Data Transmission Subsystem included integration of 41 ARP/RCC/EDTCC, 10 RCC/EDTCC, 58 RCC/EDTCC Order Wire circuits, the Offutt AFB EDTCC Modems/Cryptos/Line Units, and the Offutt AFB EDLCC A/Status Display Panel/Encoder/Decoder. The Disc File No. 3 retrofit program was continued. Author

N64-21244 Melpar, Inc., Falls Church, Va.
SIMULATION OF HELICOPTER AND V/STOL AIRCRAFT. VOLUME 2: V/STOL ANALYSIS REPORT. STUDY, EQUATIONS OF MOTION OF VERTICAL/SHORT TAKE-OFF AND LANDING OPERATIONAL FLIGHT/WEAPON SYSTEM TRAINERS
Walter McIntyre Port Washington, N.Y., Naval Training Center, Sep. 1963 117 p refs
(Contract N-61339-1205)
(NAVTRADEVCEN-1205-2; AD-438926)
The purpose of this report is to promote an understanding of V/STOL analysis for simulation purposes and to develop equations of motion in a form most compatible to either analog or real-time digital solution. A method of attack for the general V/STOL problem is developed, and various axis systems are selected. The method developed is then applied to a number

of different types of V/STOL aircraft. A mathematical model is developed that may be used as a guideline in deriving equations of motion for various types of V/STOL aircraft. In general, this model cannot be further simplified. The various terms in the final equations for a particular aircraft configuration must be analyzed for the magnitude of their contributions before final simplification is possible. The XC-142A tilt-wing aircraft and the VZ-4DA tilt-duct aircraft are used to illustrate the development of equations of motion. Equations are presented for the following types of aircraft: X-19 tilt-prop, the XV-5A fan-in-wing, and the P.1127 rotating thrust. An appendix is included that deals with basic concepts of axis systems and equations of motion. I.v.L.

N64-21341 Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center

LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT Interim Scientific Report No. 8, Dec. 15, 1963-Feb. 29, 1964

R. L. Hundstad 3 Mar. 1964 47 p
(Contract AF 33(657)-8311)
(AD-432464)

The Closed Loop MHD Research and Development Unit is in the final stages of preparation for the next test. Several minor modifications were made in the overall system; however, none of the basic features have been changed. Modifications were primarily concerned with decreasing the heat losses from the system and increasing the heat input to the system so as to permit operation with working fluids at higher temperatures. Other modifications include instrumentation additions and refinements. A new closed-loop duct with ceramic-lined end returns was partially fabricated. Author

N64-21351 Tokyo U. (Japan) Faculty of Engineering

T. MORIYA MEMORIAL SEMINAR FOR AERODYNAMICS. A 7cm X 7cm SHOCK TUBE AT THE DEPARTMENT OF AERONAUTICS, UNIVERSITY OF TOKYO Research Memorandum No. 5

Haruo Kawada Jan. 1964 24 p refs

The shock tube design criteria, the associated instrumentation, and the operational routine determined in the course of preliminary experiments are described. A brief discussion is also given on various applications of this apparatus in basic aerodynamic and gasdynamic studies. Author

N64-21386 Stanford U., Calif. Stanford Linear Accelerator Center

TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Oct.–31 Dec. 1963

Feb. 1964 94 p refs
(Contracts AT(04-3)-400; AT(04-3)-476; AT(04-3)-515)
(SLAC-27) OTS: $2.00

Progress is reported on the construction of the Stanford Linear Accelerator Center, a laboratory that will have as its chief instrument a 2-mile-long linear electron accelerator. Discussed are: (1) plant engineering; (2) accelerator structures; (3) klystron studies; (4) electronics; (5) microwave engineering and injection; (6) systems engineering and installations; (7) Mach IV program; (8) target area; and (9) preoperation research and development. N.E.A.

N64-21412 General Electric Co., Syracuse, N.Y. Defense Systems Dept.

TRANSPORTABLE PASSIVE SATELLITE COMMUNICATIONS TERMINAL Final Technical Report

R. W. Kille et al Jan. 1963 164 p
(Contract AF 30(602)-2603)
(RADC-TDR-62-502; AD-297950)

The transportable terminal consists of a van-mounted 10-kw X-band transmitter and an S-band tracking–communications receiver with related auxiliary equipment. This includes antenna pedestal servodrive equipment, an optical tracker–director, data recording equipment, etc. The antenna is a sectionalized, demountable 30-ft paraboloid with pedestal and integral trailer bed for road transportability. The feed system of the Cassegrain type employs a 5-ft-diam hyperboloid mirror with disc-on-rod feed elements located near the paraboloid vertex. Unit tests and integration tests have been made to determine the capabilities of the equipment supplied. Such data are included in this report. Author

N64-21422* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

CORIOLIS EFFECTS IN COMBINED ENVIRONMENT TESTING

Joseph C. Boyle Washington, NASA, Jun. 1964 58 p refs
(NASA-TN-D-1914) OTS: $1.50

When the movement of a body is described with respect to a set of coordinate axes that are in motion, it is necessary to distinguish between absolute and relative motions. The relations between forces, motions, and inertial properties of the body are derived herein for the special case in which the set of coordinate axes is rotating at constant angular velocity about a fixed axis. Illustrative examples are included for a body undergoing linear vibration while being rotated about a distant axis, and for a body spinning on its own axis while being rotated. Author

N64-21477 Aeronautical Research Council (Gt. Brit.)

MEASUREMENTS OF FREE-STREAM TURBULENCE IN SOME LOW-SPEED TUNNELS AT N.P.L.

P. Bradshaw and D. H. Ferriss (N.P.L.) 1963 22 p refs
(ARC-R&M-3317) HMSO: 9s.

The rms fluctuation levels in the older low-speed tunnels are found to be as follows: Compressed Air Tunnel, 0.3% rising to 0.6% at maximum speed and pressure; 13 ft × 9 ft Tunnel, 0.05 →0.2%; 9 ft × 7 ft(South) Tunnel, 0.18%; 18-in. Anemometer Tunnel, 0.2% in the unrestricted tunnel rising to 1% when running with diaphragms at low speed. Author

11 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; 13 Heat Transfer and Thermodynamics; and 24 Physics, Plasma.

N64-20776 Joint Publications Research Service, Washington, D.C.

CONTROL AND STABILITY IN SHIP DESIGN

K. K. Fedyayevskiy and G. V. Sobolev 12 May 1964 336 p refs Transl. into ENGLISH of the book "Upravlyayemost' Korablya" Leningrad, State Union Shipbldg. Ind. Publishing House, 1963 p 1-375
(JPRS-24547; OTS-64-31239) OTS: $6.00

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1. HYDRODYNAMICS OF A LOW-ASPECT-RATIO WING p 9–69 refs (See N64-20777 14-02)

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CHAPTER III
3. FORCES ON SHIPS' RUDDERS AND SCREW PROPELLERS p 133–200 refs (See N64-20779 14-27)

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4. PROBLEMS OF STEERABILITY SOLVED IN A LINEAR STATEMENT p 201–302 refs (See N64-20780 14-11)

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5. PROBLEMS OF STEERABILITY SOLVED IN A NON-LINEAR STATEMENT OF THE PROBLEM p 303–408 refs (See N64-20781 14-11)

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6. PRACTICAL CALCULATIONS OF THE STEERABILITY OF A SHIP p 409–423 ref (See N64-20782 14-11)

N64-20778 Joint Publications Research Service, Washington, D.C.
HYDRODYNAMIC FORCES AND MOMENTS ARISING ON A SHIP'S HULL IN MOTION WITH A DRIFT ANGLE AND AN ANGULAR VELOCITY
In its Control and Stability in Ship Design 12 May 1964 p 70–132 refs (See N64-20776 14-11) OTS: $6.00

The following are discussed: (1) forces and moments of an inertial nature in unsteady motion of a ship; (2) coefficients of hydrodynamic forces and moments on a ship's hull in a steady turn; (3) application of the steady-state hypothesis for hydrodynamic coefficients of forces and moments of a vortexlike nature; (4) nonlinearity of the hydrodynamic coefficients of a ship's hull; and (5) experimental methods for determining the hydrodynamic coefficients of a ship's hull. R.T.K.

N64-20780 Joint Publications Research Service, Washington, D.C.
PROBLEMS OF STEERABILITY SOLVED IN A LINEAR STATEMENT
In its Control and Stability in Ship Design 12 May 1964 p 201–302 refs (See N64-20776 14-11) OTS: $6.00

The following are discussed: (1) dynamic stability of the motion of ships; (2) differential equations of the motion of ships and their linearization; (3) investigation and derivation of the criterion of the dynamic stability of a ship; (4) free disturbed motion of a ship; (5) forced motion of a ship when the rudders are moved; (6) motion of a ship with aperiodic shifting of the rudder according to a law close to the real situation and standard tests for maneuverability; (7) process of holding a ship on course; (8) steerability of a ship when going astern; (9) stability of motion of a ship under wave conditions; and (10) steerability of a ship with an automatic pilot. R.T.K.

N64-20781 Joint Publications Research Service, Washington, D.C.
PROBLEMS OF STEERABILITY SOLVED IN A NON-LINEAR STATEMENT OF THE PROBLEM
In its Control and Stability in Ship Design 12 May 1964 p 303–408 refs (See N64-20776 14-11) OTS: $6.00

The following aspects of the ship steerability problem are discussed: (1) turning qualities of a ship and their connection with dynamic stability; (2) dependence of parameters of a steady turn on the principal dimensions of the ship—steerability diagrams; (3) effect of Froude number on the radius of a steady-state turning circle at great relative speeds; (4) calculation of the evolution period of a ship's turning circle; (5) determination of the drop in a ship's speed in an evolution; (6) simplified methods for calculating the evolution period of a ship's turning circle; (7) information on the steerability of hydroplanes, hydrofoils, and surface-effect vessels; (8) the list of a ship when maneuvering; (9) calculation of the wind drift of a ship and steerability under wind conditions; and (10) experimental methods of studying turning qualities. P.V.E.

N64-20782 Joint Publications Research Service, Washington, D.C.
PRACTICAL CALCULATIONS OF THE STEERABILITY OF A SHIP
In its Control and Stability in Ship Design 12 May 1964 p 409–423 ref (See N64-20776 14-11) OTS: $6.00

The following are discussed: (1) initial data for steerability calculations; (2) selection of a rudder for a ship in design; (3) calculation of the effectiveness of rudders; (4) checking the correspondence of the rudder effectiveness with the requirements of the design; (5) calculation of the elements of the steerability of a ship; and (6) calculation of the moment at the rudder stock. R.T.K.

N64-21031 Technische Hochschule Aachen (W. Germany) Inst. für Mechanik
LAMINAR BOUNDARY LAYERS AT CURVED SURFACES Annual Summary Report No. 3, 1 Jul. 1962–30 Jun. 1963
F. Schultz-Grunow and W. Breuer Jul. 1963 77 p refs
(Contract AF 61(052)-634)
(ARL-64-20; AD-427838)

An analytic solution of the boundary-layer equations of curved surfaces is presented. The two effects of curvature—the varying lengths of flow paths transverse to the flow, and the complete transverse inertial forces—are considered. R.T.K.

N64-21057 General Electric Co., Schenectady, N.Y. Research Lab.
BOUNDARY-LAYER TRANSITION ON A HIGHLY COOLED 10° CONE IN HYPERSONIC FLOWS
H. T. Nagamatsu and R. E. Sheer, Jr. Mar. 1964 68 p refs
(Supported by Air Force)
(REPT. 64-RL-(3622C))

An investigation was conducted in a hypersonic shock tunnel to study the laminar boundary-layer transition on a highly cooled 10° cone at the 4-ft length. The free-stream Mach number range was 6.2 to 11.1 with a stagnation temperature of approximately 1,400° K. Schlieren photographs, heat gages, analog circuits, and impact pressure probes were used to investigate the transition of the laminar boundary layer on the cone surface. In the transition region, turbulent bursts exist like those observed on a flat plate at subsonic velocities and on three-dimensional models in the firing ranges. With a smooth tip, the boundary layer was not fully turbulent for a Reynolds number of 7.4×10^6 and a Mach number of 8.5. Preliminary results with roughness indicated that the transition Reynolds number can be decreased appreciably, compared to the data with a smooth cone in the Mach number range of 8.5 to 11. With roughness, the local heat-transfer rates for a turbulent boundary layer were determined and agreed reasonably well

with the empirical theories. The sputtered platinum heat gages have an adequately rapid response time to detect passage of the turbulent bursts over the cone surface. The propagation velocity of the turbulent burst determined by this method was 0.9 of the free-stream velocity, making the disturbance velocity subsonic relative to the free stream. Author

N64-21166 Toronto U. (Canada) Inst. for Aerospace Studies
LOW-ENERGY SPHERICAL UNDERWATER EXPLOSIONS
L. E. Heuckroth Jan. 1964 224 p
(Sponsored by DRBC and ONR)
(UTIAS-96; AD-438916)

A detailed theoretical and experimental investigation of low-energy spherical underwater explosions was made. In the theoretical analysis, an explicit solution to the analogous one-dimensional problem (hydrodynamic shock tube) is first presented. The properties of the spherical high-pressure gas cavity were analyzed by simple incompressible bubble theory and detailed numerical results for the period and amplitude of oscillation and for the time variation of the radial motion, velocity, and acceleration, and the internal pressure and temperature of the bubble were compiled. The one-dimensional and incompressible spherical results are quantitatively and qualitatively compared with planar and spherical acoustic theories. With these acoustic concepts and the one-dimensional results, the simple bubble theory is refined and an improved modified bubble theory is proposed that accounts for the finite signal propagation times and the low compressibility of the water medium. Author

N64-21206 National Aerospace Lab., Tokyo (Japan)
EFFECTS OF SURFACE CURVATURE ON LAMINAR BOUNDARY-LAYER FLOW Technical Report
Nisiki Hayasi Aug. 1963 15 p refs In JAPANESE; ENGLISH summary
(NAL-TR-48)

The effects of surface longitudinal curvature K on laminar boundary-layer flow are investigated for the case where the potential flow velocity U_1 is constant and $K \propto x^{-1/2}$, x being the distance along the surface. The results of previous investigators are shown to be erroneous because of inaccurate numerical calculations. Adequate transformation for numerical calculation is derived, and correct result is obtained on an electronic digital computer. It is shown that the skin friction coefficient C_f increases with increase of $C = -K(2\nu x/U_1)^{1/2}$. Author

N64-21242 General Dynamics/Astronautics, San Diego, Calif. Space Science Lab.
EXPERIMENTAL AND THEORETICAL STUDIES OF UNDEREXPANDED JETS NEAR THE MACH DISC, APPENDIX
L. D'Attorre 19 Feb. 1964 68 p
(Contract AF 19(628)-3269; ARPA Order 363)
(GDA-DBE-64-008; AD-434014)

This appendix presents the necessary graphs to compute the shocks involved in the triple-point calculations. The graphs represent three different functions—the deflection flow angle δ as a function of the natural logarithm of the ratio of pressure across $L_N(p_2/p_1)$; δ as a function of the shock angle W_1; and the Mach number behind the shock as a function of the shock angle W_1. In all the curves, the parameter is the Mach number in front of the shock. Utilizing these curves, the triple point is computed for one of the cases in the text proper. I.v.L.

N64-21250 North American Aviation., Downey, Calif. Space Sciences Lab.
RECENT STUDIES IN BOUNDARY LAYER TRANSITION
E. R. van Driest Nov. 1963 33 p refs Presented at the Soc. of Eng. Sci. Founders' Meeting, Purdue U., Ind., 4–6 Nov. 1963
(Contract AF 49(638)-250; AF 49(638)-1178)
(SID-64-546; AFOSR-64-0589; AD-437283)

Experimental effects of controlled surface roughness and free-stream turbulence on boundary-layer transition are described, and theoretical correlations of the data presented. Recent results on the transition of boundary layers in non-Newtonian fluids are discussed. It is found that a small increase in fluid plasticity strongly delays transition. Author

N64-21256* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THEORETICAL AND EXPERIMENTAL STUDY OF THE INTERACTION OF FREE-SURFACE WAVES ON LIQUID METALS WITH TRANSVERSE MAGNETIC FIELDS (ONE-DIMENSIONAL UNSTEADY WAVES)
Vernon J. Rossow Washington, NASA, Dec. 1963 110 p refs
(NASA-TR-R-161) OTS: $2.50

The free-surface analogy that exists between pressure waves in an ionized gas and waves on the surface of a liquid metal is studied experimentally and theoretically, by considering in detail the interaction of one-dimensional waves in a channel with a transverse magnetic field. Photographic sequences are presented of the surface shapes found experimentally with mercury and the eutectic alloy of sodium and potassium (NaK). These results are compared with the corresponding surface profiles predicted theoretically by the one-dimensional mathematical method of characteristics for unsteady flows. It is concluded that the analogy is a useful tool for studying certain aspects of magnetohydrodynamic flow fields. The tests carried out in the investigation also provide information on the interaction of one-dimensional waves with a transverse magnetic field. Author

N64-21257* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF SUPERSONIC TWO-DIMENSIONAL AND AXISYMMETRIC NONEQUILIBRIUM FLOW, INCLUDING CALCULATIONS OF FLOW THROUGH A NOZZLE
James J. Der Washington, NASA, Dec. 1963 52p refs
(NASA-TR-R-164) OTS: $1.50

Chemical and vibrational nonequilibrium phenomena in steady two-dimensional and axisymmetric inviscid flow fields are studied by the analysis of flow past curved boundaries. The study consists of three parts: (1) formulation of the governing equations; (2) study of the general features of nonequilibrium flow by consideration of some mathematical properties of the nonlinear flow equations; and (3) analysis of axisymmetric flow of dissociated air through a nozzle by means of numerical computations. Author

N64-21293 Polytechnic Inst. of Brooklyn, N.Y.
SIMILAR SOLUTIONS FOR THE HYPERSONIC LAMINAR BOUNDARY LAYER NEAR A PLANE OF SYMMETRY
Massimo Trella and Paul A. Libby Feb. 1964 57 p refs
(Grant AF-AFOSR-62-409)
(PIBAL-825; AFOSR-64-566; AD-438832)

The laminar hypersonic boundary layer near a plane of symmetry is treated from the similarity point of view. Cases of

favorable and adverse pressure gradients in the plane of symmetry and of inflow to and outflow from that plane are considered. The similarity parameters are related to physical observables so that the results may be applied, at least in terms of local similarity, to determine the boundary-layer characteristics in practical problems. It is found that crossflow has significant effects on the boundary layer in the plane of symmetry when the pressure gradient is adverse. Author

N64-21324 Brown U., Providence, R.I. Div. of Applied Mathematics
ASYMMETRIC INVISCID MODES OF INSTABILITY FOR SPIRAL FLOW BETWEEN TWO CONCENTRIC ROTATING CYLINDERS Technical Report No. 55
F. E. Bisshopp and R. Y-S. Lynn Apr. 1964 20 p refs
(Contract NONR-562(07))
(Rept.-562(07)/55)

Two infinitely long concentric rotating cylinders were considered. Incompressible fluid existed between the cylinders; the asymmetric inviscid modes of instability of steady viscous flow with a pressure gradient imposed along the axial direction, were studied. Determination of the reaction of the system to small disturbances to see whether the amplitudes of such disturbances would grow or die down, was made within the framework of the linear stability theory. G.D.B.

N64-21328 Hydronautics, Inc., Laurel, Md.
ON TESTING MATERIALS FOR CAVITATION DAMAGE RESISTANCE
A. Thiruvengadam and H. S. Preiser Dec. 1963 36 p refs
(Contract Nonr-3755(00) FBM)
(TR-233-3; AD-600016)

Recent experiments with a magnetostriction apparatus show that cavitation damage rate is time dependent. This is confirmed by an analysis of the experimental data obtained in various earlier investigations. There are four zones of damage rate with respect to testing time—incubation, accumulation, attenuation, and steady state. In the steady-state zone, the damage rate varies as the square of the amplitude of oscillation within the range tested for water at 80° F. The damage rate increases with frequency and then decreases with increasing frequency. The depth of liquid in the beaker, the beaker diameter, and the depth of immersion of the specimen do not seem to affect the damage rate substantially. The average depth of erosion is independent of the diameter of the specimen.
Author

N64-21331 Air Force Systems Command, Wright-Patterson AFB, Ohio Research and Technology Div.
A NEW METHOD OF MEASURING THE CONSUMPTION OF LIQUIDS WITH THE USE OF NUCLEAR MAGNETIC RESONANCE
A. I. Zhernovoi 30 Jan. 1964 12 p refs Transl. into ENGLISH from J. Eng. Phys. (USSR), v. 5, no. 5, May 1962
(FDCL-TM-64-2; AD-432232)

A method is described that allows one to carry out automatic measurement and regulation of flow because, during the use of a phase detector, the sign of the emerging signal of the nuclear resonance depends on the mismatching sign of flow velocity with intensity of the radiofrequency in coil 1. The disadvantage of the method appears to be the delay from the moment of change of the amplitude of the signal relative to the moment of change of flow. A.W.

N64-21363 Notre Dame U., Indiana
ON HYDRODYNAMIC STABILITY OF TWO-DIMENSIONAL UNSTEADY INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS
Kwang-Tzu Yang and Matthew D. Kelleher Feb. 1964 101 p refs
(Contract Nonr-1623(11))
(TN-64-22; AD-600102)

A linearized hydrodynamic stability theory for two-dimensional unsteady incompressible laminar boundary layers over arbitrary cylinders is described. Criteria based on the instantaneous rate of change of the disturbance energy are introduced. Application of these criteria to a given unsteady laminar boundary-layer problem is analyzed, and it is found that the instantaneous disturbance-amplitude functions are governed by a partial differential equation, which can be solved by a numerical iteration scheme. Successive iterations are obtained by solving an inhomogeneous ordinary differential equation repeatedly, at the same time instants. Solutions to all ordinary equations are carried out numerically, and two examples are calculated. One deals with unsteady flow over a flat plate, and the second example treats an unsteady stagnation flow whose free-stream velocity is initially steady, then decreases, and then increases. Results of both examples are presented as typical behaviors of instantaneous disturbance-amplitude functions, and stability characteristics are presented as functions of time and initial-disturbance wave number. D.E.W.

N64-21365 California Inst. of Tech., Pasadena Karman Lab. of Fluid Mechanics and Jet Propulsion
A PRELIMINARY STUDY OF THE EFFECT OF THE FREE SURFACE ON A THREE-DIMENSIONAL CAVITY PRODUCED BY A CIRCULAR DISK
E. R. Bate, Jr. Mar. 1964 14 p refs
(Contract N123(60530)34767A)
(Rept.-E-118.15; AD-439380)

The results of a preliminary study of the effects of the free surface on the geometry of a ventilated cavity in a three-dimensional flow are presented. The experiment was performed in a free-surface water tunnel. The models used were two disks, 1 in. and 2 in. in diameter, respectively. The results are presented in graphic form. The cavity length-to-disk diameter ratios plotted against ventilation number for several values of submergence-to-disk diameter ratio are given. At a given ventilation number, the effect of the proximity of the free surface was to decrease the cavity length. A comparison between the data obtained with the 2-in. disk and the 1-in. disk shows that the cavity length ratios are larger for the 2-in. disk at equivalent submergence ratios and ventilation numbers. R.T.K.

N64-21432 Polytechnic Inst. of Brooklyn, Freeport, N.Y.
ON THE MIXING OF LAMINAR AND TURBULENT AXIALLY SYMMETRIC COMPRESSIBLE FLOWS
Gdalia Kleinstein Wright-Patterson AFB, Ohio, ARL, Jun. 1963 85 p refs
(Contract AF 33(616)-7661)
(ARL-63-108; AD-416031)

A unified analysis to solve mixing problems involving momentum, energy, and mass transfer in both laminar and turbulent axially symmetric compressible flow is presented. The method is based on the linearization of the conservation equations in the plane of the von Mises variables while retaining the essential nonlinear nature of the equations in the physical plane. The application of this method to a laminar flow problem is shown to be in good agreement with a numerical solution of the boundary-layer equations obtained by Pai. The application of this method to turbulent flow requires an expression for the eddy viscosity. Prandtl's formulation has been applied successfully to problems involving incompressible flow. To allow for compressibility effects, a possible modification of Prandtl's formulation, suggested by Ferri, is investigated. Author

12 GEOPHYSICS

Includes auroral phenomena; upper atmosphere studies; oceanography; cartography; geodesy; and geomagnetism. *For Van Allen belts see*: 28 Space Radiation. *For related information see*: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

N64-20752 Advisory Group for Aeronautical Research and Development, Paris (France)

ADVANCES IN UPPER ATMOSPHERE RESEARCH

B. Landmark, ed. (Norweg. Defence Res. Estab.) Oxford, N.Y., Pergamon, 1963 341 p refs Papers presented at the NATO Advanced Study Inst., Corfu, Jul. 1960

Available from Pergamon Press: 80s.

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N64-20753 Alaska U., College. Geophysical Obs.

THE THEORY OF MAGNETIC STORMS AND THE AURORA POLARIS

S. Chapman *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 1–5 (See N64-20752 14-12) Pergamon Press: 80s.

When a mass of solar gas, consisting mainly of electrons and protons, approaches the earth, it is retarded by the geomagnetic field, and a hollow is carved in it by the field. Electric currents are induced in the gas, and they circulate over the inner surface in a thin layer. These shield the rear of the stream from the earth's field, and they increase the earth's field within the hollow. This is the cause of the first phase of a magnetic storm in which the field at the surface, in low and middle latitudes, is increased. Magnetic storms have a second phase in which the field at the earth's surface in middle and low latitudes is decreased. This is the main phase; after reaching its peak in intensity, corresponding to the minimum of the surface field, a slow recovery sets in. A magnetic storm is accompanied by displays of aurora polaris. This is a visible sign of the entry into the earth's atmosphere of particles—electrons and protons—from outside. These are particles from the solar gas that not only excite the ionosphere air to luminescence but also ionize it. They thereby increase its electrical conductivity and enhance its power to convey electric current. The auroral zones, northern and southern, along which the aurora is most frequently seen, are the most magnetically disturbed regions of the earth. I.v.L.

N64-20754 Alaska U., College. Geophysical Obs.

THE INTERPLANETARY GAS AND THE EARTH'S OUTERMOST ATMOSPHERE

S. Chapman *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 7–10 refs (See N64-20752 14-12) Pergamon Press: 80s.

The zodiacal light, which it now appears, is caused mainly by dust, shows that there is interplanetary matter. There must also be some gas among the dust, mostly atomic hydrogen, that is an extension of the solar corona. Investigations of this gas indicate that the earth's outermost atmosphere, which is mainly atomic hydrogen, must be very hot and far extended, probably suffusing the region of the radiation belts. I.v.L.

N64-20755 Air Force Cambridge Research Center, Bedford, Mass. Electronics Res. Directorate

OPTICAL, ELECTROMAGNETIC AND SATELLITE OBSERVATIONS OF HIGH ALTITUDE DETONATIONS

Philip Newman *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 11–28 refs (See N64-20752 14-12) Pergamon Press: 80s.

Results of observations of Argus events I, II, and III are: (1) Visual aurora were sighted for all events in the launch area and in the conjugate area (vicinity of the Azores) possibly for the first event and unmistakably for the third. (2) Radar reflections were obtained for all events except in the conjugate area

for number two. (3) Changes in the magnetic field were observed in the conjugate area for Argus II and III. (4) Field-strength recordings of station GBZ in England on 19.6 kc made in the Azores and Spain showed decreases of 6 to 12 db after Argus II and III. Recordings at Stanford, California, on 18.6 kc and 17.1 kc showed a slight increase. (5) Sporadic E was noted in the conjugate area. (6) Neither absorption of cosmic noise nor production of synchrotron noise was detected by the riometers. (7) Explorer IV transmission at Torrejon, Spain, and Palo Alto, California, showed that the angular distribution of trapped electrons was always observed to be disc-like with an angular thickness between plus and minus 20° or less. The observed mean thickness at half intensity, measured normal to the boundaries of the shells, was about 90 km for Argus I and II and about 150 km for Argus III. The thickness of the shell did not have a symmetric dependence upon elapsed time. This, it can be concluded that high-altitude nuclear detonations can generate aurora and hydromagnetic waves. I.v.L.

N64-20756 Stanford Research Inst., Menlo Park, Calif.
HIGH ALTITUDE NUCLEAR DETONATIONS, SATELLITE OBSERVATIONS
R. B. Dyce *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 29–44 refs (See N64-20756 14-12) Pergamon Press: 80s.
(Sponsored by Air Force and Army)

This paper discusses the following: (1) motions of a charged particle trapped in a dipole field; (2) manmade injection of charged particles into the geomagnetic field; (3) description of Explorer IV (1958 Epsilon) satellite; (4) observations of Argus detonations; and (5) observations of high-altitude detonations in the Pacific. E.K.R.

N64-20757 Gt. Brit. Dept. of Scientific and Industrial Research, Slough Radio Research Station
SPORADIC E PHENOMENA ASSOCIATED WITH THE HIGH ALTITUDE NUCLEAR EXPLOSIONS OVER JOHNSTON ISLAND
L. Thomas and R. E. Taylor *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 45–55 refs (See N64-20752 14-12) Pergamon Press: 80s.

Sporadic E effects of nuclear explosions over Johnston Island were studied using the hourly data of f_oE_s, or fE_s, from the worldwide network of stations. The hourly observations were supplemented by frequent ionograms taken at several stations. Marked increases in sporadic E ionization occurred within 30 min of the explosions, particularly at high geomagnetic latitudes. These effects were interpreted in terms of perturbations in the outer Van Allen radiation belt. Abnormal sporadic E phenomena were also observed at several stations some hours after the explosions. The morphology of these effects is complex and does not support a simple explanation, such as the propagation of a sonic or shock wave from the explosion point. Author

N64-20758 Pennsylvania State U., University Park Ionosphere Research Lab.
RECOMBINATION PROCESSES IN THE IONOSPHERE
A. P. Mitra (Natl. Phys. Lab., India) *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 57–87 refs (See N64-20752 14-12) Pergamon Press: 80s.

The various loss processes operating in the ionosphere and contributing to the effective recombination coefficient are surveyed. Values of the coefficient are given for different heights under various conditions. Changes in the coefficient at night are discussed. Values determined during eclipses and during disturbed conditions, such as conditions of magnetic disturbances and during solar flares, are reported, and their implications are examined. Author

N64-20761 Paris U. (France) Lab. de Physique de l'Atmosphere
OPTICS OF THE UPPER ATMOSPHERE [OPTIQUE DE LA HAUTE ATMOSPHERE]
Etienne Vassy *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 137–157 ref In FRENCH; ENGLISH summary (See N64-20752 14-12) Pergamon Press: 80s.

The phenomena of light emission in the atmosphere (aurora polaris, airglow, twilight phenomena, light emission by meteors) can inform us on the nature of emitting particles, their degree of ionization, their distribution in space, their velocity, their temperature, and their relative importance. For each of the phenomena considered, the author gives precision to actual knowledge with respect to these different parameters. Author

N64-20762 Ionosphären-Institut Breisach (W. Germany)
F2 LAYER IONIZATION
K. Rawer *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 159–207 (See N64-20752 14-12) Pergamon Press: 80s.

At low latitudes there exists some connection between the influences responsible for the typical anomalies and storm effects. At temperate and high latitudes, the most important results of a perturbation are a rapid decrease of ionization in the F-2 layer, particularly after midnight. The low-latitude perturbation effects were described by the mechanism causing the anomalies, i.e., movements. It is very difficult to apply a similar description to the effects of temperate and high latitudes. The most important theoretical question for these regions is to explain how the ionization can be destroyed so rapidly. True destruction of ionization by enhanced recombination under the influence of incoming corpuscles is one of these theories; the temperate-latitude effect outside of the auroral zone is not adequately explained by this theory. Horizontal ionization transport in a western direction is Eckersley's assumption—by separation of the charges of the incoming plasma cloud, a vertical electric field pointing upward must be created in the auroral zone, and a drift movement in the western direction of the plasma as a whole should be the consequence—as the electric field also covers the neighborhood of the auroral zone, a temperate-latitude effect could eventually be explained on these lines. From recent real height research, it seems that rapid vertical plasma transport occurs even during rather small magnetic disturbances—the so-called bays. This would occur with an east-to-west electric field—as yet unexplained. Author

N64-20763 Defence Research Telecommunications Establishment, Ottawa (Canada)
THEORIES OF THE IONOSPHERIC *F* REGION. A REVIEW
J. Fejer *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 209–226 refs (See N64-20752 14-12) Pergamon Press: 80s.

Various theories of the ionospheric F-region are reviewed. These theories deal mainly with the three different causes of movements of ionization in this region, as follows: (1) diffusion that attempts to establish a hydrostatic equilibrium in the ionized component of the earth's atmosphere in the presence of the earth's gravitational field; (2) the existence of electric fields acting in combination with the earth's magnetic field; and (3) the existence of a wind (a motion of the neutral particles) within the F-region. Also discussed are theories of the magnetically disturbed F-region that propose to explain a considerable decrease of the critical frequency (sometimes preceded by a small increase) combined with an increase in the

virtual height of maximum ionization at moderate latitudes; at lower latitudes there is often only an increase in the critical frequency. The explanations are: (1) The increase in virtual height is explained by an increase in the temperature of the atmosphere. (2) A large increase in molecular oxygen content takes place with a subsequent increase in the loss coefficient at F-region heights. (3) Vertical drifts, caused by electrostatic fields, are the main cause of disturbances. I.v.L.

N64-20764 Ionosphären-Institut Breisach (W. Germany)
A NOTE REGARDING FLUCTUATION OF IONIZATION IN THE *F*2 LAYER
K. Bibl *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 227–229 refs (See N64-20752 14-12) Pergamon Press: 80s.

Considerations regarding the dynamical properties of the F-2 ionization are essential for the understanding of the relation between the ionospheric storms and the normal variations of the F-2 ionization with the time of day, season, solar cycle, and geographic and geomagnetic latitude. The "traveling disturbances" and the lunar tides are examples of the variety of phenomena occurring. In regard to the temporal and geographical variations of the distribution of ionization and to the more rapid movements of the ionization, the F-2–3000–muf is up to now the best parameter available for a description of the phenomena. One mechanism that is particularly evident is the occurrence of the "F-3-stratification" (often referred to as "G-scatter" or "lunar-layer") that occurs in the minimum of the muf values shortly after the minimum of f_0F2. The changes in the variation of the ionization of the F-2 layer, both in time and phase, were studied. Periods between 2 hr and 12 hr and recurrence tendencies were found that indicate "eigenschwingung" of the ionosphere. By comparison of muf values from three stations, it was possible to deduce time delays of the minimum phase, corresponding to a westward drift with a velocity of about 300 km/hr. No southward drift component could be traced. I.v.L.

N64-20765 Centre National de la Recherche Scientifique, Meudon (France) Service d'Aeronomie
WHISTLER PROPAGATION
L. R. O. Storey *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 231–244 refs (See N64-20752 14-12) Pergamon Press: 80s.

This paper summarizes the present situation in research on the propagation of whistlers. It is intended mainly as a guide to the published literature. Author

N64-20766 Norwegian Defence Research Establishment, Kjeller
THE ANGULAR LAW OF SCATTERING IN VHF IONOSPHERIC FORWARD PROPAGATION
T. Hagfors and B. Landmark *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 245–264 refs (See N64-20752 14-12) Pergamon Press: 80s.

A theory is presented whereby it is possible to separate the two main signal components in an ionospheric forward scatter signal, through the study of the angular power law at the receiver. The theory is applied to the analysis of data obtained on a test link, and the most likely law of turbulent scattering is deduced. It is concluded that with the sensitivity of the experiment described the continuous signal component is always caused by turbulent scattering and not by overlapping meteor-echoes. Author

N64-20767 Defence Research Telecommunications Establishment, Ottawa (Canada)
"INCOHERENT SCATTERING" AS A NEW TECHNIQUE IN IONOSPHERIC INVESTIGATIONS. A REVIEW
J. Fejer *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 265–270 refs (See N64-20752 14-12) Pergamon Press: 80s.

Theories of incoherent scattering are discussed, and the present state of the incoherent scattering theory is described. The more accurate theory takes into account the effect of the Coulomb forces on the motion of the ions as well as on that of electrons. The results of computations involved in this theory indicate that the shape of the measured spectrum not only gives an indication of the temperature of the electrons but also the ratio of this temperature to the temperature of the ions. Experimental observations of this type of incoherent scattering (back-scattering) are compatible with this theory and provide some useful, though not very accurate, information on electron densities and temperatures in the ionosphere, both below and above the peak of the F-2 region. I.v.L.

N64-20768 Saskachewan U., Saskatoon (Canada)
AURORAL BACKSCATTERING
A. Kavadas *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 271–283 refs (See N64-20752 14-12) Pergamon Press: 80s.

Two models of electron-density fluctuations are discussed. In one model, the medium is considered to be continuously ionized but not homogeneous. The inhomogeneities provide scattering centers for the incident wave. In this case it is mathematically convenient, although not physically necessary, to assume that the electron density in the inhomogeneities has values well below that of the critical density. In the other model, the medium is considered to be inhomogeneously ionized, giving rise to volume scattering. The scattering wave may be obtained from the incident wave by a mathematical operation. In this transformation, the operator itself describes the medium, and specific assumptions regarding the medium are not necessary. I.v.L.

N64-20770 National Observatory of Athens (Greece) Ionospheric Inst.
IONOSPHERIC ABSORPTION AND SOLAR ACTIVITY IN THE MIDDLE LATITUDES [ABSORPTION IONOSPHERIQUE ET ACTIVITE SOLAIRE AUX LATITUDES MOYENNES]
Michel Anastassiades, Demetrius Ilias, and Constantin Caroumbalos *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 303–309 refs In FRENCH; ENGLISH summary (See N64-20752 14-12) Pergamon Press: 80s.
(Sponsored in part by Air Force)

Systematic measurements of ionospheric absorption with a riometer allowed the evaluation of the contributions of the F-region and D-region, respectively, and also an additional regional contribution to the total absorption. The technique of simultaneous measurements on two frequencies, 27.6 and 58 mc, improved the method of distinguishing the contributions due to the D-region from that of the additional region called "extra". A detailed analysis of cosmic noise recordings on 27.6 and 58 mc shows a high correlation with solar activity. The solar eruptions of the week from 28 March through 3 April 1960 were studied in particular. From these records, the rising velocity of the source of an outburst in the coronal medium could be determined. Author

N64-20771 Defence Research Telecommunications Establishment, Ottawa (Canada)
POLAR CAP ABSORPTION

G. C. Reid *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 309–316 refs (See N64-20752 14-12) Pergamon Press: 80s.

The hypothesis that polar cap absorption (PCA) is caused by the great increase in the ionization of the lower ionosphere produced by an influx of particles of solar origin has gained general acceptance. Balloon experiments have shown that the particle flux of PCA events consists largely of solar protons, although there are no accurate estimates of the relative abundance of other particles. These experiments have also shown that the energy spectrum of the protons is steeply inclined toward the low-energy end; however, it is obvious that such a steep spectrum cannot be maintained down to very low energies, and there must be some low-energy cutoff, or at least flattening, in the spectrum. Attempts to explain the long duration of the proton flux, evidenced by the slow decay of PCA, in terms of the storage somewhere in the solar system of large numbers of protons, initially accelerated at the time of the flare, involve radial- and tongue-shaped magnetic fields of solar origin. I.v.L.

N64-20772 Kiruna Geophysical Observatory (Sweden)
RIOMETER MEASUREMENTS, WITH SPECIAL REGARD TO SOME RELEVANT PROPERTIES OF THE UPPER ATMOSPHERE
Bengt Hultqvist *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 317–329 refs (See N64-20752 14-12) Pergamon Press: 80s.
(Contract AF 61(514)-1314)

Riometer measurements are discussed, with special regard being given to the absorption cross section of electrons, the electron-density profile, the time constants of the lower ionosphere, the ratio of collision detachment to photo detachment coefficients, and the relation between electron production rate and observed absorption. Author

N64-20821 Weapons Research Establishment (Australia)
IONOSPHERIC DATA FOR AUGUST, 1963 FROM SALISBURY, SOUTH AUSTRALIA
Feb. 1964 31 p refs
(CPD-1963/8(S))

Tables of hourly values of ionospheric parameters are given for the Salisbury station, located at 34.7° S and 138.6° E, for August, 1963. The parameters are: f_bE_s, f_0E_s, f_0E, f_0F_1, f_0F_2, f_{min}, $h'E_s$, $h'E$, $h'F$, $h'F_2$, and M (3000) F_2. I.v.L.

N64-20837 International Council of Scientific Unions, Paris (France) Comite International de Geophysique
ANNALS OF THE INTERNATIONAL GEOPHYSICAL YEAR, VOLUME XXXVI: CATALOGUE OF DATA IN THE WORLD DATA CENTERS, 1 JULY 1957-31 DECEMBER 1959
Oxford, N.Y., Pergamon Press, 1964 752 p refs

Data presented cover the following areas: (1) the IGY calendar record; (2) meteorology; (3) geomagnetism; (4) aurora; (5) airglow; (6) the ionosphere; (7) solar activity; (8) cosmic rays; (9) longitudes and latitudes; (10) glaciology; (11) oceanography; (12) rockets and satellites; (13) seismology; (14) gravimetry; and (15) nuclear radiation. I.v.L.

N64-20841 Queens U., Belfast (Northern Ireland)
OBSERVATIONS OF THE 6300 A OI EMISSION OF THE NIGHTGLOW WITH A PRESSURE SCANNING FABRY-PEROT INTERFEROMETER
A. H. Jarret, M. J. Hoey, and L. Paffrath [1963] 15 p refs
(AFCRL-64-370; AD-439688)

A photoelectric recording was made of the 6,300A-nightglow profile. The optical flats available were of 7-cm clear aperture, and the width of the exploring slit was 0.1 of an order separation. A schematic diagram is included that shows the layout of the photoelectric pressure-scanning interferometer used. An analysis of the temperatures obtained from the 6,300A emission in the predawn and posttwilight periods was made, and yielded values that are presented in graphic form. The probable errors for the temperatures are indicated on the graphs. With the instrument described, it was impossible to record the 6,300A emission during the period between posttwilight and predawn enhancements. R.T.K.

N64-20907 Isotopes, Inc., Westwood, N.J.
PROJECT STAR DUST Eighth Quarterly Report
James P. Friend, Herbert W. Feely, and Micah W. M. Leo 7 Apr. 1964 44 p
(Contract DA-49-146-XZ-079)
(DASA-1308; AD-600602)

High concentrations of total beta activity and of short-lived fission products, such as barium^{140}, were found in the stratosphere of the Northern Hemisphere during late 1962 and early 1963, mainly as a result of the late 1962 Soviet series of nuclear weapons tests. The apparent atmospheric burden of strontium^{90} had increased to approximately 7.8 megacuries by January–February 1963. The apparent burden of manganese^{54} in the stratosphere of the Northern Hemisphere, corrected for decay to October 15, 1961, reached 45 megacuries by late 1962 and 75 megacuries by January–February 1963. This is probably due to the 1961 and 1962 Soviet test series. Large quantities of antimony^{124} were produced during the 1962 Soviet test series. The stratospheric distribution of the cosmic ray product, beryllium^{7}, approximated the theoretical distribution during early 1960 and mid-1961, but artificial beryllium^{7}, produced during the 1961 Soviet and 1962 U.S. test series, distorted the distribution of this nuclide during 1962. The distributions of lead^{210} and polonium^{210} in the stratosphere appear to fit the pattern that might be expected from the mixing of radon and its daughter products across the troposphere from the troposphere. The vertical distributions of these nuclides in the northern polar troposphere during 1962 also seem to fit this hypothesis. I.v.L.

N64-21024 Army Materiel Command, Hanover, N.H. Cold Regions Research and Engineering Lab.
INVESTIGATION OF SHEAR ZONES IN THE ICE CAP MARGIN THULE, GREENLAND
George K. Swinzow Feb. 1964 21 p refs
(CRREL-93; AD-600074)

The shear moraine phenomenon of glaciers is examined in the light of new evidence collected in the general Tuto area during 1958–1959. The formation and composition of silt bands, some heavy accumulations of boulders and gravel, and streaks of clayey ice exposed during the excavation of two ice tunnels in the margin of the ice cap are described in detail. Surface investigations have furnished information on the location and concentration of the glacial-ice–snow–drift-ice interface, variations of silt, sand, and rock bands, and other materials produced by the shear surfaces. A general view of the outcropping shear moraines shows a tendency toward a broad arch-shaped pattern, perpendicular to the direction of flow and, in most cases, parallel to the ice edge. Motion measurement between two ice levels is presented in the form of limiting angles on a velocity distribution curve. Author

N64-21030 Technische Hochschule Munchen (W. Germany) Elektrophysikalisches Inst.
ELF INVESTIGATIONS Summary Report No. 1, 1 Apr. 1962-30 Jun. 1963

H. L. Konig [1963] 25 p
(Contract AF 61(052)-603)
(AFCRL-64-81; AD-439090)

Two observation stations, one in Munich, Germany and the other in Kingston, R.I., are being used to observe the fluctuations of the earth's magnetic field in the frequency region around 10 cps. A time mark generator, described in detail, has been developed for the purpose of putting synchronized time marks triggered by an ordinary mechanical clock on the paper tape records with a precision of 2 to $5 \cdot 10^{-4}$. Author

N64-21198 Weapons Research Establishment (Australia)
IONOSPHERIC DATA FOR JANUARY, 1963 FROM SALISBURY, SOUTH AUSTRALIA
Dec. 1963 26 p ref
(CPD-1963/1(S))

Tables of the hourly values of the customary ionospheric parameters are given for the station at Salisbury. Author

N64-21199 Weapons Research Establishment (Australia)
IONSPHERIC DATA FOR FEBRUARY, 1963 FROM SALISBURY, SOUTH AUSTRALIA
Jan. 1964 26 p ref For abstract see N64-21198 14-12 (CPD-1963/2(S))

N64-21200 Weapons Research Establishment (Australia)
IONOSPHERIC DATA FOR MARCH, 1963 FROM SALISBURY, SOUTH AUSTRALIA
Jan. 1964 26 p ref For abstract see N64-21198 14-12 (CPD-1963/5(S))

N64-21201 Weapons Research Establishment (Australia)
IONOSPHERIC DATA FOR MAY, 1963 FROM SALISBURY, SOUTH AUSTRALIA
Jan. 1964 26 p ref For abstract see N64-21198 14-12 (CPD-1963/3(S))

N64-21235 Lichtklimatisches Observatorium, Arosa (Switzerland)
VERTICAL OZONE DISTRIBUTION OVER AROSA. VERTICAL OZONE DISTRIBUTION AND STRATOSPHERIC CIRCULATION Technical Report, No. 2, Aug. 1962-Jul. 1963
Hans Ulrich Dütsch Jan. 1964 64 p refs
(Grant AF-EOAR-62-115)
(AFCRL-64-303; AD-439211)

Umkehr data from 12 months (August 1962 to July 1963) of routine observations at Arosa, Switzerland, were evaluated for vertical ozone distribution on an electronic computer. Mean values and some outstanding anomalies observed during the period are discussed. Earlier data (1956 to 1959) have been reevaluated using the same secondary scattering corrections as have been applied since observations were resumed in 1961. A short discussion of all the data and results is given. Author

N64-21287 Joint Publications Research Service, Washington, D.C.
CHANGE IN THE SPECIFIC ELECTRICAL CONDUCTIVITY OF MINERALS AND ROCKS WITH THEIR AGE
F. S. Zakirova 5 Jun. 1964 9 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 154, no. 6, 21 Feb. 1964 p 1325-1327
(JPRS-24960; OTS-64-31421) OTS: $0.50

It has been demonstrated that the specific electrical conductivity of minerals and rocks at a high temperature depends upon age, namely, the more ancient the minerals and rocks are, the lower is their electrical conductivity. On the basis of a study of more than 200 specimens, the existence of this phenomenon was confirmed. The phenomenon was found to be associated with the accumulation of valency and β radiation, originating as a consequence of the radioactive transmutation of K^{40} and Ca^{40}. R.T.K.

N64-21305* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE ACOUSTIC HEATING OF THE POLAR NIGHT MESOSPHERE
Kaichi Maeda Repr. from J. Geophys. Res., v. 69, no. 7, 1 Apr. 1964 p 1381-1395 refs
(NASA-RP-181)

As a part of the dynamical heating emphasized by Hines, the contribution of aerodynamically produced atmospheric acoustic waves to the warming of the polar night mesosphere is reexamined with the polar night jet stream in the stratosphere as the source, and with the thermal structure of the polar upper atmosphere playing a part in propagation and absorption. Owing to the relatively small transmissivity of the thermosphere for long-period sound waves, most acoustic heating does not take place above the 200-km level, but rather below 100 km, or around the mesopause, and although acoustic output power from the polar jet stream is more than 10^5 times larger in winter than in summer, acoustic heating is not sufficient to compensate for the cooling rate around the mesopause in winter, unless the wind velocity of the polar night jet stream continually exceeds 200 m/sec. Author

N64-21383 California U., Berkeley Space Sciences Lab.
CONSOLIDATED QUARTERLY PROGRESS REPORT FOR PERIOD ENDING 1 MAY 1964
24 Apr. 1964 53 p refs
(Ser. No. 5, Issue-25)

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N64-21416 California U., Los Angeles
MASS SPECTROMETER STUDIES OF IONIZATION PROCESSES IN NITROGEN Scientific Report No. 1
D. D. Briglia [1963] 160 p refs
(Contract AF 19(628)-273)
(AFCRL-64-259; AD-600311)

The phenomenon of spontaneous ionization in nitrogen is discussed, and the auroral afterglow is attributed to this process. The ions that are extracted from the nitrogen plasma afterglow were analyzed with an electric quadrupole mass spectrometer. The mass spectrometer measurements were supplemented by RF absorption studies. It is concluded that the precursor event in the afterglow is the production of free electrons and ions. The observed afterglow light is a result of rapid ion–neutral and ion–electron collisions. Author

N64-21427 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A SMALL MULTI-PURPOSE ROCKET PAYLOAD FOR IONOSPHERIC STUDIES
S. J. Bauer and J. E. Jackson Washington, NASA, Jun. 1964 21 p refs
(NASA-TN-D-2323) OTS: $0.50

A miniaturized version of the two-frequency cw-propagation experiment was developed for ionospheric measurements using small sounding rockets. The choice of relatively high frequencies for the propagation experiment permitted the use of a very simple configuration for the rocket antenna. The signals received on the ground at the two frequencies were about 4μv/m for a slant range of about 180 km. About half of the payload space for a Nike-Cajun rocket is occupied by the cw-propagation experiment, leaving the remaining space available for one or two secondary experiments. A very high degree of frequency stability was provided in the two-frequency transmitter to permit Doppler radial-velocity measurements at 73.6 Mc. A stability of 1 part in 10^8 was achieved in ballistic flight, and about 1 part in 10^6 during the propulsion phase. If ranging errors during the propulsion phase can be overcome, the complete rocket trajectory can be calculated with an accuracy of 1% of the maximum altitude from the Doppler data at a single receiving site. Author

13 HEAT TRANSFER AND THERMODYNAMICS

Includes ablation; cooling; heating; and other thermal effects. *For aerothermodynamics see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings, Rotors, and Control Surfaces. *For combustion see*: 26 Propellants and Combustion. *For related information see*: 11 Fluid Mechanics.

N64-20796* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
VAPOR PHASE PHENOMENA
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 83–86 (See N64-20783 14-01) OTS: $5.00

There has been growing interest shown in the behavior of materials in metals in the presence of vapors at high temperatures. Vapor-phase corrosion is much less than that of solids in contact with the liquid metals, and it is much less severe in the common oxides. In hydrogen systems, a large amount of corrosive attack is ordinarily observed in the condensing vapor region. It is important to minimize boiling instabilities and liquid carryover in order to eliminate errors in the interpretation of vapor-phase corrosion. A.W.

N64-20797* Brookhaven National Lab., Upton, N.Y.
TWO-PHASE MECHANISMS
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 87–89 (See N64-20783 14-01) OTS: $5.00

In a schematic boiling loop, dissolution occurs primarily where the solute-free condensate contacts the metal surface. Slugging may cause corrosion in the superheater, and bumping may carry saturated droplets into it. Adsorption on metal surfaces may occur even in dry vapor when liquid wets solid. At the liquid-vapor interface in static reflux capsules, Gibbs adsorption isotherm predicts concentration or depletion of the solute. A.W.

N64-20804* Argonne National Lab., Ill.
BOILING STABILITY
Paul A. Lottes *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 257–271 (See N64-20783 14-01) OTS: $5.00

In liquid-metal corrosion tests, flow instability would upset temperature and concentration gradients, disturb impurity accumulations at liquid-vapor interfaces, affect the entrainment of liquid droplets in vapor regions, and change the location of sensitive corrosion sites in the system. In order to determine corrosion rates, steady-state flow must be insured. There are two types of boiling instability—one related to a multivalued pressure drop and the other related to momentum changes. The first type generally can be avoided by orificing, and the second type is avoided by providing a pump as well as by orificing. A.W.

N64-20869 European Atomic Energy Community, Brussels (Belgium)
A COMPARISON BETWEEN THE CODES FOR THE CALCULATION OF THERMAL SPECTRA IN HOMOGENEOUS MEDIA

M. G. Tamagnini and C. Ponti Joint Nucl. Res. Center, Ispra Estab. (Italy) Sci. Data Process. Center, Mar. 1964 25 p refs Presented at the Convegno di Fis. dei Reattori, Pavia (Italy), 28 Nov.–1 Dec. 1963
(EUR-1605.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 50 Belg. Fr.

It is well known that the thermal spectra evaluation depends on the choice of a library for the absorption cross sections, on the choice of the scattering kernel, and also on the numerical method employed for the solution of the Boltzmann equation. Considered were the differences obtained in the spectra when using with the same scattering kernel the three codes SOFOCATE, THESIS II, and THERMOS, or when using in the same code different kernels. The cross sections library was the same for all the calculations. Infinite mixtures of absorbers in H_2O or D_2O moderators were considered. Author

N64-20874 Milan U. (Italy) Istituto di Fisica Teorica
GALERKIN'S METHOD AND THE DOUBLE P_1 APPROXIMATION FOR THERMAL FLUX CALCULATION [IL METODO DI GALERKIN E LA DOPPIA P_1 PER IL CALCOLO DEL FLUSSO TERMICO]
Adelia Daneri and Adriana Daneri Brussels, EURATOM, Feb. 1964 79 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-006-60-7 CETI)
(EUR-533.i) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 125 Belg. Fr.

DESTHEC DP codes solved the transport equation for thermal neutrons in a slab system; for the energy, Galerkin's method with double P_1 approximation is used. Galerkin's method shortens execution time and reduces the number of storage locations in comparison with the multigroup theory. Comparison was made with the Thermos code that solves the transport equation in integral form; agreement between Thermos results and DESTHEC DP is good. Author

N64-20881 European Atomic Energy Community, Brussels (Belgium)
VISUALIZATION OF NUCLEAR BOILING OF WATER AT ATMOSPHERIC PRESSURE AND SIMULTANEOUS MEASUREMENT OF SURFACE TEMPERATURE VARIATIONS [VISUALISATION DE L'EBULLITION NUCLEE DE L'EAU A PRESSION ATMOSPHERIQUE ET MESURE SIMULTANEE DES VARIATIONS DE TEMPERATURE DE SURFACE]
C. Bonnet, E. Macke, and R. Morin Joint Nucl. Res. Center, Ispra Estab. (Italy) Heat Exchanges Ser., Mar. 1964 24 p ref In FRENCH, ENGLISH summary
(EUR-1622.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

This report deals with a study on local wall temperature fluctuations due to the formation of isolated bubbles in pool-boiling of water at atmospheric pressure. Those temperature fluctuations are made visible by the elongation of a luminous spot in the same optical plane as the phenomenon. The whole is filmed with a high-speed camera. The set up of Ni–Ni Cr thermocouple for measuring rapid surface temperature variations is described. In agreement with the experimental results, a physical model of bubble formation based on a one-dimensional mathematical model is presented. Author

N64-20893 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THERMODYNAMICS OF REFRACTORY COMPOUNDS OF BERYLLIUM (OXIDES, BORIDES, CARBIDES, AND NITRIDES) An Annotated Bibliography
Jack B. Goldmann, comp. Apr. 1963 103 p refs
(Contract NOrd-17017)
(SB-63-16; Rept. 3-80-63-3; AD-439445)

The thermodynamics of beryllium and its refractory compounds (oxides, borides, carbides, and nitrides) from 298.15° to 6,000° K is the basis for this annotated bibliography. References consist of theoretical and experimental studies that appeared in print from 1880 to 1962. Author

N64-20989 Dimensions, Inc., Hempstead, N.Y.
THERMODYNAMICS OF FAILURE AND AGING
Martin Ruderfer *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 361–374 refs (See N64-20967 14-09)

Energy is required to produce the changes that occur in aging. The thermodynamic approach quantitatively relates any aging process with energy mechanisms in a universal manner; it states that every aging process derives from four physical factors represented by s, q, k, and P. These may or may not be interrelated and may or may not be time-dependent. The aging process is completely determined when these factors are known, and vice versa. Current life testing procedures do not attempt measurement of lifespan versus power. All machines, including the human body, wear out; all major body components in man and animals are capable of repairing themselves except one, the nervous system. The thermodynamic approach to aging affords some quantitative information that may possibly be applicable to this problem. A.W.

N64-21023 Aberdeen Proving Ground, Md. Ballistic Research Labs.
EVAPORATIVE COOLING SHROUDS FOR SOUNDING ROCKET NOSECONES
James O. Pilcher, 11 Feb. 1964 14 p
(BRL-1547; AD-600726)

Prior to launching, it is often necessary to maintain the rocket nosecone temperature within certain limits. The primary heat sources that cause the nosecone temperature to increase are solar radiation, wind convection, and internal power dissipation. The evaporative cooling shroud is a cover of absorbent material that is tailored to fit the rocket nosecone outer surface, and its purpose is to remove the heat by means of evaporation. This cover is saturated with a fluid having the desired evaporation temperature and is placed over the nosecone. The heat applied to the shroud is then transferred to the atmosphere. The nosecone temperature remains at approximately the evaporation temperature of the fluid until all of the fluid has evaporated. The shroud is removed either by a hand lanyard or by rocket motion. The following five criteria were considered in determining the shroud design: (1) facility of removal from the nosecone; (2) ability to withstand handling in the field; (3) low attenuation of electromagnetic fields radiated by nosecone instrumentation; (4) chemical effects of the fluid upon the shroud material; and (5) capacity to absorb sufficient evaporation fluid. The following criteria were considered for choosing a suitable evaporation fluid: effects of the chemical properties of the fluid on nosecone structural materials, evaporation temperature, and heat of evaporation. Author

N64-21055 Los Alamos Scientific Lab., N. Mex.
PRESSURE OSCILLATIONS INDUCED BY FORCED CONVECTION HEAT TRANSFER TO TWO PHASE AND SUPERCRITICAL HYDROGEN. PRELIMINARY EXPERIMENTS
Rodney S. Thurston 22 May 1964 93 p refs
(Contract W-7405-ENG-36)
(LAMS-3070) OTS: $2.00

Pressure oscillations induced by forced convection heat transfer to liquid hydrogen were probed, using a preliminary

apparatus that cooled from ambient to LH_2 temperatures during each run. Acoustic modes due to Helmholtz and open-open pipe resonances were observed at subcritical and supercritical pressures. These oscillations did not develop when the inlet hydrogen was superheated. Pressure fluctuations in the form of sawteeth, negative pulses, and beats were observed above and below the critical pressure. A mode that primarily occurred above the critical pressure and one associated with subcritical two-phase flow were also observed. Experimental evidence indicated that heat transfer was substantially better in two-phase flow than in supercritical flow at low-flow rates, that pressure drop increased after the apparatus had cooled near LH_2 temperatures at moderate flow rates, and that greater axial temperature gradients were obtained in the slower cooldowns. Author

N64-21178 Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.
THE EFFECT OF AN ELECTROSTATIC FIELD ON THE CONDENSATION OF VAPOR Technical Documentary Report, Sep. 1962-Aug. 1963
Henry R. Velkoff and John H. Miller Feb. 1964 54 p refs
(RTD-TDR-63-4008; AD-433238)

This experimental program was conducted to determine whether electrostatic fields could be applied effectively to increase the heat-transfer coefficient in the condensation of vapor. A series of tests using several types of electrodes and various field strengths was conducted to study the effects of various electrostatic actions on the condensation process. In these tests, Freon-113 was vaporized in a tank and condensed on a cooled copper plate. Results of these tests indicate that large increases in heat-transfer coefficient can be realized by applying an electrostatic field with a screen electrode placed parallel to a cooled copper plate. The increases were controllable and readily reproduced. Author

N64-21179 Rensselaer Polytechnic Inst., Troy, N.Y.
PROBABLE INTERFACE TEMPERATURES OF SOLIDS IN SLIDING CONTACT Technical Documentary Report, 1 May-31 Aug. 1963
F. F. Ling and S. L. Pu Wright-Patterson AFB, Ohio, Res. and Tech. Div., Feb. 1964 29 p refs
(Contract AF 33(657)-10058)
(RTD-TDR-63-4184; AD-433587)

Typical time-dependent, surface-temperature distribution obtained by indirect measurement is presented, as well as area-averaged temperature-jump data at the interface for high Peclet number; the jump is associated with macroscopic thermal resistance mechanism across the interface. Moreover, a simple stochastic model was introduced to show that, whereas the measurable temperature far away from the interface may be smooth functions with respect to distance from the interface, the surface temperature will always be fluctuating, and the magnitude of these temperature flashes are shown. Author

N64-21202 Weapons Research Establishment (Australia)
HEAT CONDUCTION IN SINGLE-LAYER AND DOUBLE-LAYER WALLS, WITH BOUNDARY CONDITIONS APPROPRIATE TO AERODYNAMIC HEATING
G. Jepps Jul. 1963 131 p refs
(HSA-16)

Solutions of the one-dimensional Fourier heat conduction equation, for walls bounded by two parallel planes, are found by means of the Laplace transformation for wall boundary conditions such that either surface heat flow or temperature is a prescribed function of time. Using these solutions, approximate methods are derived for the treatment of single-layer walls subjected to aerodynamic heat transfer on one surface. In addition, basic temperature operators are used to show how certain double-layer walls can be treated by these single-layer methods. Thin wall approximations are considered in detail, conditions for their validity are investigated, and as an example, it is shown how the heat transfer coefficient can be deduced from the temperature at the inner insulated surface of a thin wall. Examples illustrating other important results are also given. Author

N64-21225 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AN EXPERIMENTAL STUDY OF HEAT TRANSFER WITH MELTING OF A METAL AND WITH MOLTEN METAL FED THROUGH A POROUS WALL IN A SUPERSONIC STREAM
I. A. Zotikov and L. N. Bronskiy 30 Oct. 1962 9 p refs
Transl. into ENGLISH from Inzh.-Fiz. Zh., Akad. Nauk Belorusskoi SSR (Minsk), v. 5, no. 4, 1962 p 10–14
(FTD-TT-62-1328/1+2+4; AD-292236)

Experiments are described concerning heat transfer on the surface of a body that is being melted in a supersonic stream while molten metal is being fed to the surface through a porous wall. Discussed are quantitative relations that are explained by the influence of the liquid film runoff upon heat transfer. J.L.D.

N64-21255* National Aeronautics and Space Adminstration. Ames Research Center, Moffett Field, Calif.
RADIATIVE HEAT TRANSFER BETWEEN PLANAR SURFACES WITH FILLETED JUNCTURES
William Prichard Jones Washington, NASA, Dec. 1963 23 p refs
(NASA-TR-R-157) OTS: $0.75

A numerical analysis is presented of the effect of a circular fillet on the thermal radiation exchange between planar surfaces of zero conductivity intersecting at a sharp angle. Temperature variation along the surface for a constant heat-transfer and local heat-transfer variation for a constant wall temperature is obtained. Surface emissivity, which is assumed to be independent of wavelength and temperature, and fillet size are varied in the analysis. The "hot spot" for the unfilleted structure is found at the intersection of the planar surfaces but is moved to the point of juncture in the case of a filleted structure and is reduced in values. For planar surfaces that intersect at a right angle, the temperature and local heat-transfer distributions for various fillet sizes are compared with the corresponding distributions of the unfilleted surface. Author

N64-21273* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
APPROXIMATION OF THE EIGENVALUES FOR HEAT TRANSFER IN LAMINAR TUBE SLIP FLOW
Robert M. Inman Repr. from AIAA J., v. 2, no. 2, [1964] p 373–374
(NASA-RP-161)

Discussed is the possible application to laminar tube slip flow of the method of Sellars et al who, for convective heat transfer in laminar continuum tube flow with uniform wall heat flux, have obtained asymptotic formulas for the eigenvalues and coefficients through a generalization of constant-wall-temperature results. From a comparison made, it appears that the method of Sellars et al. has definite application for determining the eigenvalues and coefficients for heat transfer in laminar tube slip flow, although the first few eigenvalues apparently become slightly inaccurate, i.e., do not fit. Interactions between the velocity and temperature fields, such as thermal creep, have been neglected. I.A.A.

N64-21278* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECT OF GAS COMPOSITION ON THE ABLATION BEHAVIOR OF A CHARRING MATERIAL

Nick S. Vojvodich and Ronald B. Pope Repr. from AIAA J., v. 2, no. 3, Mar. 1964 p 536–542 refs Presented at AIAA Conf. on Phys. of Entry into Planetary Atmospheres, Cambridge, Mass., 26–28 Aug. 1963

(NASA-RP-179; AIAA Paper 63-465)

The ablation behavior of a charring material was evaluated in high-velocity streams of arc-heated air, nitrogen, and argon. The purpose of the investigation was to determine (1) whether chemical reactions occur between the material and its environment, (2) whether the reactions are homogeneous and/or heterogeneous, and (3) what the influence of the reactions is upon the heating rate to the surface of the material. The behavior of the material proved to be highly sensitive to the composition of the test gas. For air, both heterogeneous and homogeneous reactions were found to occur, and the surface heating rates resulting from each type of reaction were evaluated and compared to theory. In the case of homogeneous reactions, experiment was higher than theory, whereas the opposite was true for the heterogeneous reactions. Author

N64-21280* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

SHOCK-TUBE THERMAL CONDUCTIVITY

M. R. Lauver Repr. from Phys. of Fluids, v. 7, no. 4, Apr. 1964 2 p refs

(NASA-RP-191)

A shock-tube study of the thermal conductivities of gases was conducted. A thin-film platinum-on-Pyrex resistance thermometer was mounted normal to the shock travel in the center of a shock tube 3-in. by 3-in. cross section. The distance from the diaphragm to the thermometer was 18 ft 9 in. Based on shock speed, reflected shock temperatures of 665° to 8,580° K were obtained in argon, using a helium driver. The experimental data were in general agreement with those predicted by analyses developed by Smiley and Thomson. The data thus far obtained do not have the precision necessary to distinguish between theoretical k's (thermal conductivity) that differ by only a few percent. However, they do indicate that, to about 8,600° K, the generally accepted values for argon are approximately correct. I.v.L.

N64-21302* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

THERMAL CONDUCTIVITIES OF GASEOUS H_2O, D_2O, AND THE EQUIMOLAR H_2O-D_2O MIXTURE

Charles E. Baker and Richard S. Brokaw Repr. from J. Chem. Phys., v. 40, no. 6, 15 Mar. 1964 p 1523–1528 refs

(NASA-RP-176)

Measurements have been carried out over the temperature range 380° to 525° K using a four-cell hot-wire thermal-conductivity apparatus. At the lower temperature the thermal conductivities of H_2O and D_2O are identical, but at the highest temperature the conductivity of D_2O is larger by 8 to 9 parts per thousand. Conductivities of the equimolar mixtures lie midway between the conductivities of the pure components. Results are analyzed to test a recent hypothesis that a resonant exchange of rotational quanta causes the thermal conductivity of a polar gas to seem anomalously low in relation to its viscosity. It is concluded that the interchange of rotational energy between neighboring dipoles may be important, but that exact resonance is probably not required, at least in the case of water vapor. Author

N64-21361 Rensselaer Polytechnic Inst., Troy, N.Y.

THE NONLINEAR INTERACTION OF A FINITE NUMBER OF DISTURBANCES TO A LAYER OF FLUID HEATED FROM BELOW

Lee A. Segel 14 Apr. 1964 62 p refs

(Sponsored by ONR and NSF)

(RPI-Math-Rep.-64; AD-600115)

It is predicted that at a temperature difference a little less than that at which motion starts according to linear stability theory, a steady hexagonal convective pattern will develop from finite amplitude instabilities in a horizontal layer of fluid heated from below. This is because the first disturbances to start growing must be the triplet of two-dimensional "rolls" that form angles of 60° with each other and whose amplitudes and phases first fall in certain critical ranges. The growth of these disturbances stabilizes all other disturbances and is such that ultimately the right phases and amplitudes occur to give hexagonal cells. If the temperature difference is increased somewhat beyond its critical value, the hexagonal pattern becomes unstable and a two-dimensional pattern is predicted. Author

N64-21483 Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

THERMAL CONDUCTIVITY OF URANIUM DIOXIDE AND ARMCO IRON BY AN IMPROVED RADIAL HEAT FLOW TECHNIQUE

T. G. Godfrey, W. Fulkerson, T. G. Kollie, J. P. Moore, and D. L. Mc Elroy Jun. 1964 72 p refs

(Contract W-7405-ENG-26)

(ORNL-3556) OTS: $1.75

A description of an improved radial heat flow technique for measuring the thermal conductivity of solids in the range −57° to 1,100° C is presented. The technique yielded results with an accuracy of ±1.5% and a reproducibility of ±0.1%. Meaningful measurements were limited to 1,100° C by Pt vs Pt−10% Rh thermocouple instability. The thermal conductivity of polycrystalline UO_2 was measured from −57° to 1,100° C and reveals a maximum in κ near room temperature. The thermal resistance, $1/\kappa$, showed a linear dependence with temperature from 200° to 1,000° C. The slope of the $1/\kappa$-temperature plot was 0.0223 cm/w, and this was independent of impurity content. The thermal conductivity of polycrystalline Armco iron was measured between 100° and 1,000° C and was found to be within ±2% to 3% of the best values reported in the literature. The temperature dependence of the thermal conductivity of iron is largely controlled by the electronic contribution. The thermal conductivity of iron was represented by four linear equations for the temperature ranges 0° to 436°, 436° to 786°, 786° to 910°, and 910° to 1,000° C. A slope change of 30% at 436° C may be coupled to a minimum in the thermoelectric power of iron near this temperature. A minimum in the thermal conductivity occurs near 786° C and is associated with the Curie transformation. A 4% decrease in the thermal conductivity was observed at the α-γ transformation (910° C). Author

14 HUMAN BEHAVIOR

Includes crew training and evaluation; piloting; and psychological factors. *For simulators see*: 10 Facilities, Research and Support. *For related information see*: 16 Life Sciences.

N64-21048 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)
STUDIES ON THE NITROGEN METABOLISM IN FROG LIVER AFTER WHOLE-BODY IRRADIATION. II. TIME- AND DOSE-DEPENDENCE OF NITROGEN EXCRETION FROM ISOLATED FROG LIVER AFTER WHOLE-BODY IRRADIATION
M. Antonijevic and D. Lebez Dec. 1963 7 p refs
(NIJS-R-422)

The time and dose dependence of the nitrogen excretion in frog livers was studied. Pronounced differences were observed between time–course of the liver nitrogen excretion of frogs irradiated with 400 r and 650 r. With the lower dose the nitrogen excretion reached maximum value when the perfusion was started 24 hours after whole-body irradiation. Higher level of the excreted nitrogen was observed after the dose of 650 r with the maximum value obtained if the organ was isolated 10 hours after exposure. Author

N64-21049 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)
STUDIES ON THE NITROGEN METABOLISM IN FROG LIVER AFTER WHOLE-BODY IRRADIATION. III. EFFECT OF HISTAMINE AND CYSTEINE ON NITROGEN EXCRETION FROM ISOLATED FROG LIVER AFTER WHOLE-BODY IRRADIATION
M. Antonijevic and D. Lebez Dec. 1963 7 p refs Submitted for Publication
(NIJS-R-423)

In the isolated perfused livers of whole-body irradiated frogs with 650 r(Co^{60} source), histamine improves the nitrogen balance if injected into animals before irradiation, while nitrogen catabolism is increased if histamine is administered directly into the organ after whole-body irradiation. On the other hand, cysteine injected prior to irradiation with 400 r only slightly modifies the changes in nitrogen excretion induced by irradiation. Author

N64-21081 Illinois U., Urbana Aviation Psychology Lab.
EXPERIMENTAL STUDIES OF HUMAN VIGILANCE Final Report
Jack A. Adams Hanscom Field, Bedford, Mass., Electron. Systems Div., Feb. 1963 43 p refs
(Contract AF 19(604)-5705)
(ESD-TDR-63-320; AD-408279)

A series of experiments was conducted on human vigilance or the characteristics of long-term human attentiveness for the occasional occurrences of signals that are to be detected and reported. Emphasis was given complex visual displays with multiple stimulus sources and alpha-numeric signals of the general class found in semiautomatic man–machine systems. Two major devices were developed for the laboratory study of vigilance, and periods of continuous watching were from 2.5 to 3 hours. Some experiments tested the arousal hypothesis, which holds that alertness depends on the level of environmental or internal response-produced stimulation associated with the task. Other experiments studied the effects of temporal and spatial uncertainty of signal occurrence, the effects of repeated daily sessions, and a method for training vigilance behavior to effect a relatively stable improvement in visual monitoring. A review of the literature was also made. Author

N64-21122 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
IMPROVEMENT OF THE HUMAN OPERATOR'S TRACKING PERFORMANCE BY MEANS OF OPTIMUM FILTERING AND PREDICTION
W. W. Wierwille 7 Jan. 1963 19 p refs

Optimum filtering is applied to man–machine tracking control systems so as to improve their performance in tracking random waveforms. Two different design approaches are developed. In the first, the predicted input is properly displayed for interpretation by the human operator, who is then allowed to track in a manner that makes maximum use of his higher-order abilities. In the second approach, it is shown that a previously designed tracking control system can be optimized by using a series filter. It is found that the use of the series filter avoids, to a great extent, the problems of the human's changing transfer function, thus allowing proper application of the optimum filtering theory. The most fundamental idea contained in this paper is that of using optimum prediction and filtering to overcome timelags, rise times, and nonminimum phase characteristics in man–machine systems. Author

N64-21220 Dunlap and Associates, Inc., Santa Monica, Calif. Western Div.
PROFICIENCY TESTS FOR MISSILE TECHNICIANS MAINTAINING THE TELEMETRY GROUND STATION EQUIPMENT AN/SKH-1 AND AN/UKR-10
Clyde A. Brictson Feb. 1964 31 p refs
(Contract Nonr-2978(00))
(ND-64-36; AD-431894)

The procedures used to develop an advanced telemetry performance test for missile technicians are described. Fleet fault data collection and analysis procedures are discussed in terms of providing a basis for test simulation of representative equipment faults. The test is designed to allow diagnostic appraisal of the technician's ability to detect chassis malfunctions during preventive maintenance tasks and provides a systematic step-by-step assessment of fault isolation and correction procedures. The test is integrated with a previously developed performance test for administrative compatibility and flexibility. Author

N64-21312 Institute for Research, State College, Pa. Div. of Mathematical Psychology
MICROSTRUCTURE OF GUESS PROCESSES: PART C Report No. 7
Masanao Toda Bedford, Mass., Electronic Systems Div. [1963] 51 p refs Presented at Harvard Statistics Colloq., 1962
(Contract AF 19(628)-2968)
(ESD-TDR-63-548; AD-600474)

Trial-to-trial changes in the proportion of human subjects predicting the occurrence of one of two events in a complex sequence of binary events (probability learning) are analyzed in terms of several simple models. The direction of change predicted by linear-operator reinforcement models (Estes, Bush, and Mosteller) is wrong on about 75% of the trials. A no-learning model, a time-dependent decay model, and a cycle-dependent decay model are used to provide some insight into the nature of probability learning. Some suboptimal procedures for estimating parameters of stochastic processes are compared. The method of minimum absolute error is recommended. Author

N64-21373 Dunlap and Associates, Inc., Santa Monica, Calif.
PROFICIENCY TEST FOR MISSILE TECHNICIANS MAINTAINING THE AN/SKQ-1 TELEMETERING GROUND STATION EQUIPMENT, VOLUME III Technical Report
Feb. 1964 86 p refs
(Contract Nonr-2978(00))
(ND-64-37; AD-431945)

The purpose of the research was to develop a proficiency test for missile technicians maintaining the AN/SKQ-1 Telemetering Ground Station Equipment for the Tartar, Terrier, and Talos

missile systems. Described are the various steps in the test development and evaluation. Subsequent sections of the report provide a background to test development, present the approach taken in developing the test, and discuss the characteristics of the final test forms. N.E.A.

N64-21381 Princeton U., N.J.
ON THE VISUAL DETECTION OF ACCELERATED MOTION
Ross D. L. Filion (Ph.D. Thesis) Sep. 1963 84 p refs
(Contract AF 49(638)-381; Grant AF-AFOSR-441-63)
(AFOSR-64-0189; AD-433109)

The absolute threshold for acceleration in the motion of a seen object was investigated. Subjects were presented with constant velocity or positively accelerated motions of the CRT (cathode ray tube) beam on an oscilloscope screen; their task was to judge whether the pip achieved a final velocity greater than or equal to its initial velocity. The main conclusions drawn were: (1) Subjects' judgments concerning the presence or absence of acceleration in a stimulus motion are based on information deriving from within the motion itself and not on external aspects. (2) Subjects apparently detect acceleration by some procedure of estimating and comparing earlier and later average velocities in the motion display. (3) Effects analogous to the velocity transposition phenomenon occur in the detection of acceleration when viewing field dimensions are changed and when spatial or temporal size of the motion path is changed. (4) The human organism's performance in dealing with the second-time derivatives of visual stimulus magnitudes is not as good as performance in dealing with first-time derivatives of the same stimulus magnitudes. R.T.K.

15 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; sensors and transducers; and telescopes and cameras. *For related information see*: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

N64-20834 Naval Radiological Defense Lab., San Francisco, Calif.
NAVAL AERIAL PHOTOGRAPHIC ANALYSIS **Final Report**
F. L. Vuillemot 31 Jul. 1963 54 p refs
(Proj. Sedan)
(PNE 230F) OTS: $1.25

The procedures and results of extensive preshot and postshot aerial photographic coverage by two supersonic F8U-1P's are described and evaluated. Objectives were to use photo aircraft to document preshot and postshot ground zero area conditions, to provide aerial photographs for immediate onsite use, and to evaluate this type of photographic coverage. During each mission, black and white, infrared, and color film was used. There was no particular advantage to using color and infrared film; black and white film was adequate. Interim photointerpretation stereo techniques provided the initial gross crater measurements. More deliberate photogrammetric efforts were later employed to locate crater contours and vertical profiles, relative to the bottom of the crater. The strong correlation of the residual contamination and the highly visible upwind and crosswind base surge deposition area was demonstrated. Naval aerial photographic coverage is of considerable value in the rapid assessment of the gross effects of large scale nuclear excavation events. Author

N64-20849 Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.
THE DYNAMIC BEHAVIOR OF THE CARBON HUMIDITY ELEMENT ML-476
Heinz H. Grote and Reinhold M. Marchgraber Aug. 1963 28 p refs
(USAELRDL-TR-2379)

Measurements of the step-function response of Carbon Humidity Element ML-476 taken at different environmental temperatures and with humidity steps of different magnitude are presented. The measurements were performed on a two-pressure system of high precision, with a test port modified to allow exposure of the elements under test to controlled humidity steps of negligible rise-time anywhere within the operating temperature range of the elements. The response characteristics obtained show a fast initial response followed by a slower drift to equilibrium. Mathematical models of second and third order for the response of the carbon element are given in a form yielding to the restoration of the input time function from the measured output of the humidity sensor. Though data restoration with this method is possible with a high degree of precision even with temperature-varying coefficients in the modeling differential equation, the obtainable accuracy is limited by the quality of the chosen model and especially by the "memory" feature of the carbon element, its hysteresis, and the consequent necessity for using a mean calibration curve in the evaluation of actual flight data. Author

N64-20854 Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.
PRECISE MEASUREMENT OF ATMOSPHERIC TEMPERATURES
Albert R. Tebo Dec. 1963 11 p refs
(USAELRDL-TR-2405; AD-430573)

A simple method was devised for the continuous measurement of atmospheric temperature on a linear scale, with an instrumental accuracy of $\pm 0.06°$ C over the temperature range $-40°$ to $+40°$ C. A bead thermistor is used as the sensor in an off-balance Wheatstone bridge. Eight 10° spans are covered by switching different fixed resistors into the balance arm of the bridge. Full-scale output for a 10° span can be adjusted to 10 mv with a 6-v d.c. source, and this output can be conveniently fed into a null-balance-type potentiometric recorder. Switching from one span to another is accomplished automatically by microswitches on the pen stops of the recorder at both ends of the scale. With an identifying printer or marker pen controlled by these switches, the temperature-measuring system can be made completely automatic. Author

N64-20934 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
TURBOJET CONFIGURATION FOR CATEGORY III OPERATION
In its Second Intern. Aviation R&D Symp.: All-Weather Landing Systems [1963] p 79–88 (See N64-20932 14-22)

The turbojet configuration proposed fulfills the following criteria: (1) The system is suitable for backfitting into jet aircraft, now in service, with minimum modifications. (2) All-weather landing can be obtained, over a period of time, as the equipment is proven and flight crews are made aware of equipment capability. (3) The crew can be relieved of the routine tasks that can be done better by a machine, and they can therefore concentrate on monitoring tasks. An airborne system is

proposed that is based on ILS (Instrument Landing System), radio altimeter, and the associated flare computer-coupler. The primary system is automatic and uses the autopilot for control. An automatic throttle-control system is included. A complete manual system, displayed to the pilot by means of his panel instruments, will supplement the automatic system and allow pilot takeover. The information displayed will be adequate for manually flying a complete approach; however, a more thorough monitoring job can be done by using the automatic system to fly the aircraft. A failure above a given minimum altitude should normally mean a go-around to assess the situation. A simplified diagram of the system is included. R.T.K.

N64-20982 Autonetics, Anaheim, Calif.
APPLICATION OF THE ELECTRON MICROPROBE ANALYZER TO THE STUDY OF SILICON SWITCHING DIODES
Paul Pietrokowsky (North Am. Aviation) *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 245–267 refs (See N64-20967 14-09)

Study was made of a silicon switching diode constructed by two different processes, A and B. Techniques used to produce the process A device led to the formation of tin-rich intermediate phases at the interface of the gold ball and nickel wire. Analysis indicated these phases to be AuSn and Au_7Sn_{16}, which have little cohesion; this makes it reasonable to try to obtain gold-rich intermediate phases at this critical interface. In the switching diode made by process B, the number of tin atoms has been reduced, and an extensive region of beta-AuSn eutectic mixture is formed. When used as a scanning beam instrument, the probe can investigate an area the size of the device itself. The electron microprobe analyzer is extremely sensitive to the detection of small amounts of an impurity element. A.W.

N64-20998 General Motors Corp., Kokomo, Ind. Delco Radio Div.
OBSERVATIONS OF THE PHYSICS OF FAILURE OF SEMICONDUCTOR DEVICES BY X-RAY RADIOGRAPHY
Ray L. Silver *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 525–534 (See N64-20967 14-09)

Radiographic analyses can be used to observe solder disturbances caused by electrical and/or thermal failure modes. By a variation of radiographic exposure and photographic copy, voiding can be observed readily for engineering evaluation of the solder bond. The area of bond can be estimated with a planimeter, and bond thickness by establishing relative intensity factors. Radiographic analyses are not limited to transistors but include also rectifier devices; neither are they limited to catastrophic failure modes. However, there are mechanical discrepancies in semiconductor devices that are not resolved or observed by radiographic methods. A.W.

N64-21097 Naval Radiological Defense Lab., San Francisco, Calif.
A SIMPLE DISPLAY SYSTEM FOR RECORDING RAPID CHANGES IN MASS SPECTRA
Kenneth A. Lincoln 17 Mar. 1964 17 p refs
(DASA-1453; USNRDL-TR-731; AD-600158)

A convenient photographic readout for recording rapidly changing mass spectra (of the order of milliseconds) generated by a time-of-flight instrument is achieved by a combination of two oscilloscopes equipped with Polaroid Land cameras. One of the oscilloscopes is operated by established techniques to display, quantitatively, peak height versus time for any one of the preselected mass peaks. Simultaneously, the second oscilloscope in the system displays a raster presentation of approximate peak height of all the peaks in the spectrum as a function of time. In the latter case, the discrete m/e values are displayed on the horizontal axis as dots, and the magnitude of the ion peaks is displayed semiquantitatively by z-axis modulation (intensification of the dots); time is presented as the trace is displaced vertically by a raster voltage that is synchronized with the time base of the first scope. Author

N64-21107 Parametrics, Inc., Waltham, Mass. Chemistry Dept.
DETECTION OF HYDROGEN ABOARD AEROSPACE FLIGHT VEHICLES Technical Documentary Report, 1 Jan.-31 Dec. 1963
Orlando Cucchiara, T. Donaghue, and David Chleck Wright-Patterson AFB, Ohio, AF Aero Propulsion Lab., Apr. 1964 57 p refs
(Contract AF 33(657)-8916)
(APL-TDR-64-51; AD-600153)

A detailed investigation to determine the applicability of radiochemical exchange techniques, using "Kryptonates," for detecting hydrogen vapor concentrations of 1% or less aboard aerospace flight vehicles, was conducted. The optimum host material was found to be a 50-50 mixture of aluminum oxide and kryptonated platinum dioxide. This mixture can detect hydrogen in concentrations less than 1% with a response time of less than 0.5 sec. An experimental model demonstrating the feasibility and applicability of the kryptonate detection system was constructed. Author

N64-21112 Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROLS DIVISION ANNUAL PROGRESS REPORT, SEPTEMBER 1, 1963
C. J. Borkowski and C. S. Harrill Jun. 1964 148 p refs
(Contract W-7405-ENG-26)
(ORNL-3578) OTS: $2.75

The current status of the following areas is discussed: (1) semiconductor radiation-detector research; (2) measurement of delayed light from plants at 10^{-3} to 10^{-5} sec after illumination; (3) electronic systems and components; (4) radiation-monitoring systems; (5) radiation-detection instruments and components; (6) data handling and computation; (7) process instrumentation and control-systems engineering; (8) process-instrumentation development (process instrumentation, power-control units, test and calibration instruments, and analytical instruments); (9) reactor instrumentation and controls development; (10) reactor instrumentation and control-systems engineering; (11) support for the high-voltage accelerator program; and (12) costs and manpower support of laboratory programs. Also, a list of publications and of papers presented at professional meetings is presented. I.v.L.

N64-21124 Aeronautical Research Labs., Melbourne (Australia)
ON THE MECHANISM, PROPERTIES AND APPLICATION OF SEMI-CONDUCTOR TRANSDUCERS
C. Rohrbach and N. Czaika May 1963 38 p refs Transl. into ENGLISH from Materialprüf., v. 4, 1962 p 189
(ARL-20)

The dependence of electric resistance in silicon and germanium on stress (piezo-resistance effect) is discussed, along with applications to transducers and to extensometry (semiconductor strain gages). The most important properties of semiconductor strain gages are described—linearity, sensibility to temperature, and creep and fatigue behavior. Further considerations relate to the application of the semiconductor strain gages to the experimental stress analysis and in general to the electric measurement of mechanical magnitudes. The semiconductor strain gage is compared with the wire resistance strain gage. Author

N64-21168 General Dynamics Corp., San Diego, Calif. John Jay Hopkins Labs. for Pure and Applied Sciences
A CONDENSER PROBE FOR ABLATION MEASUREMENTS
R. H. Stahl 15 May 1963 10 p
(Contract AF 29(601)-2207)
(GAMD-4255; AD-434851)

The preliminary work is described of the development of a condenser-type probe for the measurement of the depth of penetration of an ablative plasma incident on a solid target. Several versions of the condenser probe were constructed, and about 20 probes were tested in ablation experiments. The results of the experiments are summarized as follows: (1) apparent shorting of the condenser, usually 20 μsec to 30 μsec after the arrival of the pressure pulse; (2) a distracting initial signal, not caused by ablation and more or less random in polarity; (3) relatively high noise level at all times; and (4) a positive pulse sometimes observed at late times (~50 μsec after the arrival of the pressure front) having a polarity that indicates discharging of the condenser. R.T.K.

N64-21175 National Bureau of Standards, Boulder, Colo.
PERFORMANCE MEASUREMENTS ON THE NM-30A SERIAL NO. 346-40, FIELD-INTENSITY METER Technical Note No. 7
A. H. Dove N.Y., 10 Oct. 1963 51 p refs
(Contract AF 30(602)-2385)
(NBS-7971; RADC-TDR-63-531; AD-437782)

This report reviews briefly procedures for and results of measurements performed on the field intensity meter NM-30A covering the frequency range of 20 to 400 mcs. Performance measurements of this meter were conducted to determine the accuracy of the instrument and its ability to furnish realistic data when measuring radiofrequency fields. These measurements are used for reference and evaluation and to correlate with other field strength meters performing the same type of tests in the same environment. An effort has been made to describe tests that affect field strength measurements and to supplement the conclusions of the report with calibration charts and curves. Author

N64-21177 Naval Research Lab., Washington, D.C.
CHARACTERISTICS OF AIR FILTER MEDIA USED FOR MONITORING AIRBORNE RADIOACTIVITY Final Report
L. B. Lockhart, Jr., R. L. Patterson, Jr., and W. L. Anderson
20 Mar. 1964 19 p refs
(NRL-6054; AD-600292) OTS: $1.00

A comparison was made of the more important characteristics of the available filter materials currently in use by various systems for monitoring airborne radioactivity throughout the world. Most of the materials described are commercially available. The filter characteristics measured are such physical properties as tensile strength, thickness, density, ash content, retentivity toward 0.3μ dioctyl phthalate (DOP) aerosol particles as a function of air velocity, retentivity toward airborne fission products and natural radioactive aerosols (radon daughters) at several air velocities, flow rate as a function of pressure drop across the filter, and the relative rates of clogging by atmospheric dust. The observation of a rapid change in flow with dust loading of some of the filter media suggests the systematic study of such changes as possibly a simple procedure for monitoring the dust content of the atmosphere. Author

N64-21234 General Dynamics/Astronautics, San Diego, Calif.
RESEARCH DIRECTED TOWARD THE INVESTIGATION OF SUITABILITY OF THE GLOTRAC TYPE G TRANSPONDER FOR USE IN THE RANGE CALIBRATION SATELLITE, PART B Final Report
R. Braun 15 Mar. 1964 182 p refs
(Contract AF 19(628)-3274)
(GD/A-63-1195(B); AFCRL-64-240(B); AD-438936)

Results are discussed of a study program directed toward determining what modifications in the GLOTRAC type-G transponder are required to make the transponder suitable for operation in the Range Calibration Satellite (RCS). In particular, results are discussed of a test program to provide information on the reliability of the GLOTRAC type-G transponder when operating under simulated RCS environmental conditions. Tests conducted included the following: (1) electromagnetic interference tests—RF-conducted and radiated interference, antenna-conducted interference, audiofrequency-conducted susceptibility, RF-conducted and radiated susceptibility, and intermodulation; and (2) environmental tests—operating temperature (25°, 0°, −10°, and −18° C), nonoperating temperature cycling at 100° and −62° C, altitude (100 hours at 10^{-6}-mm Hg), nonoperating shock, random acoustical noise, and life. P.V.E.

N64-21246 Daystrom, Inc., Newark, N.J. Weston Instruments and Electronics Div.
PRODUCTION ENGINEERING MEASURE FOR RUGGEDIZED TAUT BAND SUSPENSION PANEL METERS PER SIGNAL CORPS TECHNICAL REQUIREMENTS SCS-43A Quarterly Progress Report No. 11, 1 Oct.-31 Dec. 1963
[1963] 13 p
(Contract DA-36-039-SC-85952)
(AD-440166)

Work to establish facilities and the competence to produce ruggedized taut-band suspension-panel meters is discussed. As a result of the work carried out to date, it is concluded that: (1) A 1% accuracy and balance requirement on meters having a scale length of 3 inches or less is not practical. (2) Ruggedized taut-band instruments having a scale length of 3 inches or more can be manufactured to near an accuracy and balance requirement of 1%. (3) Realistic accuracy limitations after tests of vibration, a random drop, and high shock cannot be established from engineering or preproduction samples; values must be established on samples from mass production. P.V.E.

N64-21247 RCA Service Co., Inc., Patrick AFB, Fla. Data Reduction
PHOTOGRAMMETRIC DATA REDUCTION ANALYSIS CALIBRATION OF COMPARATORS FOR BALLISTIC CAMERA DATA RCA Data Reduction TR-63-1
Ralph A. Gugel Patrick AFB, Fla., Missile Test Center, Dec. 1963 100 p refs
(Contract AF 08(606)-5300)
(MTC-TDR-63-10; AD-437640)

The procedures for calibrating a precision leadscrew-type comparator are described, and the results of the calibration of ballistic plate comparators are given. The errors to be calibrated are: (1) periodic leadscrew error, (2) scale error and secular leadscrew error, (3) weave and curvature of the ways, and (4) nonperpendicularity of axes. Each calibration is described in detail by giving the reading procedures, calibrated standards necessary, error models fit, and methods of analyzing the results. Author

N64-21339 Air Force Academy, Colo. Frank J. Seiler Research Lab.
"SITTING TIME" AND STRAIN EFFECTS IN A .00005 INCH DIAMETER COLD WIRE FOR LOW DENSITY SHOCK TUBE USE
Charles F. Stebbins 7 Apr. 1964 23 p refs
(SRL-64-1; AD-438450)

The very fine, cold wire (diameter ≤ .00005"), a comparatively new instrument for use in fast-transient, free-molecule-flow problems, was used to measure heat-transfer rates within a plane shock wave up to shock Mach numbers of 7.5. In an effort to resolve these discrepancies between theory and practice, several characteristics of the very fine, cold wire were investigated, including strain-induced-resistance changes and molecular "sitting time". A vibrational analysis of the fine wire was performed. Drag forces imposed in the low-density shock tube were simulated in a continuum-flow, subsonic-wind tunnel, and under similar dynamic conditions, wire resistance varied according to theory, eliminating concern with strain-induced error for a wide range of shock-tube work. "Sitting time" was three orders of magnitude smaller than shock-passage time, and caused no appreciable error in the results. The elimination of concern with these two effects under certain conditions brings the cold wire closer to the status of an acceptable instrument for fast-transient, free-molecule-flow applications. Author

N64-21348 National Bureau of Standards, Washington, D.C.
CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS
22 Nov. 1963 109 p refs Repr. from Federal Register, v. 28, no. 145, Pt. II, 26 Jul. 1963 and v. 28, no. 218, Nov. 7, 1963
(NBS-Misc. Publ.-250) GPO: $0.70

To promote accuracy and uniformity in physical measurements, the National Bureau of Standards provides calibration and testing services for a wide variety of standards and instruments. These services, together with the fees for their performance, are listed in the following sections: electricity, meteorology, heat, radiation physics, analytical and inorganic chemistry, mechanics, metallurgy, building research, and physical chemistry. R.T.K.

N64-21350 Dow Chemical Co., Golden, Colo. Rocky Flats Div.
AN ALPHA COUNTER FOR GLOVE BOX OPERATIONS
W. H. Tyree and V. P. Johnson 15 Aug. 1963 12 p refs
(Contract AT(29-1)-1106)
(RFP-348) OTS: $0.50

A transistorized counter that indicates alpha contamination with a flashing light is described. A charged capacitor is utilized to provide anode potential for an air proportional detector. Author

N64-21374* California Inst. of Tech., Pasadena Graduate Aeronautical Labs.
PRESSURE GAUGE WITH ONE-TENTH MICROSECOND RISETIME FOR SHOCK REFLECTION STUDIES
D. Baganoff Repr. from Rev. Sci. Instr., v. 35, no. 3, Mar. 1964 p 288–295 refs
(Grant NsG-40-60)

A pressure gage having a risetime of 0.1μsec, no overshoot, a dwell time of 5μsec, and being capable of sensing a pressure jump of 10-mm Hg is described. Pressure-time traces obtained with the gage on the end wall of the 17-in.-diam low-pressure shock tube are presented, showing details of the pressure profiles on the end wall for reflecting shock waves. Author

N64-21379 California U., Berkeley Space Sciences Lab.
THE RUBIDIUM VAPOR MAGNETOMETER AS A VECTOR INSTRUMENT FOR RECORDING MICROPULSATIONS
R. E. Warren 5 Dec. 1963 22 p refs
(Contract Nonr-222(89))
(Ser. 4, Issue 87; AD-432847)

A semiquantitative investigation of the induction effects of micropulsations was conducted using only vertical component observations of the earth's magnetic field. A discussion of the use of a scalar field magnetometer to measure the vertical component exclusively is presented. The field procedure for using these Z-meters and the possibility of expanding the system to a three-component device are also considered. R.T.K.

N64-21385 Aeronautical Research Labs., Melbourne (Australia) Dept. of Supply
PROJECTED SYMBOLIC DISPLAYS FOR GENERAL AIRCRAFT
J. R. Baxter Mar. 1963 47 p refs Previously Announced as N63-19904 19-22
(ARL/HE-14)

The Projected Symbolic Display concept is now gaining increased support as a means of providing instrument information in a form wholly compatible with visual information from the outside world. Several such displays have been proposed for large transport aircraft, and, in this report, the practicability of a simplified version for general aircraft is examined in detail. There are two separate approaches to the simplification of the display—one based on the use of ILS information to locate the runway symbol and the other on the use of ground beacons. Even after gross simplifications of the equipment, either type of simplified projected display appears to have substantial advantages over a standard instrument panel. The type based on ground beacons would seem to provide the better aid for the pilot. Author

N64-21394 Tactical Air Command, Langley AFB, Va.
OPERATIONAL TEST AND EVALUATION OF F-100/F-105 CAPABILITY, TACTICS AND TECHNIQUES FOR AERIAL DELIVERY OF PHOTOGRAPHIC PRINTS
Laurence F. Gardner et al Feb. 1964 49 p
(TAC-TR-63-32; AD-432408)

Flight tests were performed by the USAF Fighter Weapons School to develop a system for the aerial delivery of photographic prints from the F-100- and F-105-type aircraft. The test was performed in three phases—functional, ballistic, and tactics/technique—consisting of a total of 61 drops. The finalized aerial delivery system consisted of a modified dart target recovery chute canister with the pilot chute of an F-105 drag chute attached. A modified LAU-10/A Zuni Rocket Launcher was used to carry and launch the delivery containers. The aerial delivery system was successful up to 400 kias at a minimum release altitude of 50 ft. Optimum drop conditions are 300 to 350 kias at a release altitude of 50 to 100 ft above ground level. Releases within these conditions assure recoverability and reusability of the delivery containers. Present low-level weapons delivery techniques are applicable for releasing the delivery containers from both the F-100 and the F-105D Author

16 LIFE SCIENCES

Includes biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems and space sickness. *For related information see*: 14 Human Behavior; and 28 Space Radiation.

N64-20749* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
FIRE AND BLAST HAZARDS FROM METEOROID PENETRATION
In its Space-Cabin Atmospheres, Pt. II 1964 p 47–77 refs (See N64-20744 14-26) GPO: $1.00

The meteoroid penetration of vehicle walls results in the passage of molten metal and vaporized materials (projectile and wall) into the cabin space or fuel compartments. Spallation of the cabin wall may well result in secondary missiles that may penetrate containers, disrupt tubes and pipes, and even cut electric wires. The release of flammable liquids and gases by these secondary projectiles creates fire hazards. However, the most significant hazard in cabin penetration appears to be the formation of an "explosive" flash of oxidizing metal vapors in the gaseous environment of the cabin. Experiments showing the pathological effects of "explosive" flashes are discussed. I.v.L.

N64-20811 Research Triangle Inst., Durham, N.C. Operations Research Div.
SHELTER MEDICAL SUPPORT SYSTEM STUDY Final Report
W. T. Herzog, W. L. Wells, and W. J. Cromartie 31 Aug. 1963 135 p refs
(Contract OCD-OS-62-271)
(OU-107)

This study asked four questions: (1) Can a single, community, fallout shelter be medically self-sufficient? (2) Can a community fallout-shelter complex be medically self-sufficient? (3) What demands will a medical-support system place on the community civil-defense services? (4) What is the best medical-support system? Answers to these questions were: (1) The 94% of the nonradiation sick and injured would survive in the single shelter if a doctor and proper supplies are provided. (2) The community-shelter complex has many variables connected with it, and would work efficiently only if all these variables, such as communications and transportation, were efficiently organized. (3) The demands on community civil-defense services would be so great after nuclear attack that a medical-support system would not receive adequate support. (4) The best system is minimum transfer of cases and maximum availability of medical personnel and supplies in the single community shelter. G.D.B.

N64-20823 Atomic Energy Commission, Washington, D.C. Div. of Technical Information
PROCEEDINGS OF THE TASHKENT CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, VOLUME III
Ya. Kh. Turakulov, ed. Mar. 1964 856 p refs Transl. into ENGLISH of Tr. Tashkentsk. Konf. Po Mirnomu ispol'z. At. Energ., T. III, Tashkent, Isd. AN Uz.SSR, 1961
(AEC-TR-6293) OTS: $8.75

Contained in these proceedings are results of investigations using radioactive isotopes and nuclear radiations in the field of medicine, biology, and agriculture. Great emphasis was placed on the changes in the organism under the action of small doses of X-ray radiation, on the formation of iodinated substances in the organism when radioiodine is used, and on an evaluation of the functional state of the vascular system by the radioisotope method. Various cases of the use of labeled atoms to study exchange processes in the organism, various aspects of metabolism in animals in the normal state and during radiation sickness, and the physiological-biochemical action of ionizing radiation on plants are discussed. A number of reports indicate general ways to use ionizing radiation in agriculture. The proceedings are designed for scientists and specialists of scientific research institutions and enterprises, who use radioactive isotopes and nuclear radiations in their work. Author

N64-20827 Joint Publications Research Service, Washington, D.C.
EFFECTS OF RADIATION SICKNESS
M. I. Ravich-Shcherbo et al 21 May 1964 20 p refs Trans. into ENGLISH from Byull. Eksptl. Biol. i Med. (Moscow), no. 12, 1963
(JPRS-24704; OTS-64-31304) OTS: $0.50

CONTENTS:
1. CAUSES OF THE PROTECTIVE EFFECT PRODUCED BY BACTERIAL ANTIGENS IN ACUTE RADIATION SICKNESS M. I. Ravich-Shcherbo and L. G. Prokopenko p 1–5
2. ACCUMULATION OF I^{131} BY THE SKIN AND HAIRS OF ANIMALS AND MAN A. Ya. Loshak and A. V. Terman p 6–11
3. REGENERATION OF THE SCIATIC NERVE IN ACUTE RADIATION SICKNESS O. N. Bayshtruk and Ya. I. Ryss p 12–17

N64-20943 Joint Publications Research Service, Washington, D.C.
STUDIES IN MEDICAL RADIOLOGY
4 May 1964 62 p refs Transl. into ENGLISH of 6 articles from Med. Radiol. (Moscow), v. 9, no. 2, Feb. 1964 p 22–28, 64–71, 75–84, 94–103
(JPRS-24452; OTS-64-31197) OTS: $1.50

CONTENTS:
1. THE CONDITION OF CARCINAMOTOUS LARYNGEAL MUCOSA AFTER X-RAY THERAPY S. N. Lapchenko p 1–8 refs
2. CASE OF RADIATION SICKNESS FROM INTERNAL IRRADIATION Ye. I. Safronov p 9–19 refs (See N64-20944 14-16)
3. TEMPERATURE REACTION TO IRRADIATION IN MONKEYS N. A. Volokhova p 20–27 refs (See N64-20945 14-16)
4. SERUM PROPHYLAXIS AND THERAPY OF BACTERIAL INTOXICATIONS IN IRRADIATED ANIMALS D. R. Kaulen and T. I. Bulatova p 28–34 refs (See N64-20946 14-16)
5. THE USE OF CYBERNETICS IN THE DEVELOPMENT OF RADIATION THERAPY I. O. Kruglyakov, L. D. Lindenbraten, and Ye. A. Likhtenshteyn p 35–46 (See N64-20947 14-16)
6. CLASSIFICATION OF RADIATION SICKNESS G. D. Baysogolov and A. K. Gus'kova p 47–57 refs (See N64-20948 14-16)

N64-20944 Joint Publications Research Service, Washington, D.C.
CASE OF RADIATION SICKNESS FROM INTERNAL IRRADIATION
Ye. I. Safronov *In its* Studies in Med. Radiol. 4 May 1964 p 9–19 refs (See N64-20943 14-16) OTS: $1.50

A description is presented of the symptoms, medical treatment, and reactions to the treatments of a patient who sustained a one-stage oral intake of 2.03 millicuries of radium. P.V.E.

N64-20945 Joint Publications Research Service, Washington, D.C.
TEMPERATURE REACTION TO IRRADIATION IN MONKEYS
N. A. Volokhova *In its* Studies in Med. Radiol. 4 May 1964 p 20–27 refs (See N64-20943 14-16) OTS: $1.50

A study was made of the rectal and skin temperatures of monkeys (Macacus rhesus) irradiated with a dose of 15,000 r, 10,000 r, 6,500 r, and 350 r, and the results were compared with similar studies made on dogs. In monkeys, in contrast to dogs, a marked drop in body temperature was observed immediately after irradiation with a dose of 15,000 r. In dogs, even those irradiated with very much higher doses (30,000 r), there was no such sharp drop in body temperature. A comparison of the temperature reactions after irradiation with a dose of 350 r in dogs and monkeys revealed no essential differences in the first few hours or days after irradiation. However, beginning with the 13th day, marked differences were noted in the nature of the temperature curve. In the majority of cases, the dogs died with elevated temperatures, whereas a low body temperature was characteristic of the monkeys. It is concluded that the relationship between the nature of the temperature reaction in monkeys and dogs and the radiation dose, within limits of 6,500–30,000 r, differs in that in the former, in response to massive irradiation, a deep hypothermia develops, and in the latter, a phasic alternation of hypothermia and hyperthermia occurs. P.V.E.

N64-20946 Joint Publications Research Service, Washington, D.C.

SERUM PROPHYLAXIS AND THERAPY OF BACTERIAL INTOXICATIONS IN IRRADIATED ANIMALS

D. R. Kaulen and T. I. Bulatova *In its* Studies in Med. Radiol. 4 May 1964 p 28–34 refs (See N64-20943 14-16) OTS: $1.50

Investigations were undertaken to study: (1) the effectiveness of seroprophylaxis and serotherapy of bacterial toxicoses in irradiated animals; and (2) the effect of bone-marrow transplantation on the seroprophylaxis of diphtheria intoxication in animals irradiated with a lethal dose. Conclusions reached as a result of the studies were: (1) The effectiveness of seroprophylaxis of botulism intoxication is reduced in accordance with the radiation dose and route of administration of the toxin by 1.5 to 4 times. The greatest disorder is observed after oral administration of the toxin. (2) The effectiveness of serotherapy is reduced even further, by 1,070 times after intravenous, and by 28 times after oral administration of the toxin. (3) Reduction of the effectiveness of seroprophylaxis and serotherapy can be compensated by increasing the quantity of antitoxin administered. (4) Transplantation of bone marrow increases the strength of passive immunity, but this increase is small (by 1.4 times). The effectiveness of seroprophylaxis in bone-marrow-treated animals 20 days after irradiation had returned to near the original level. P.V.E.

N64-20947 Joint Publications Research Service, Washington, D.C.

THE USE OF CYBERNETICS IN THE DEVELOPMENT OF RADIATION THERAPY

I. O. Kruglyakov, L. D. Lindenbraten, and Ye. A. Likhtenshteyn *In its* Studies in Med. Radiol. 4 May 1964 p 35–46 (See N64-20943 14-16) OTS: $1.50

Three general aspects of the problem are discussed: (1) the need for cybernetics; (2) the possibility and forms of utilization, particularly the use of computers for automation of the control of the therapeutic process; and (3) measures for carrying out the problem posed. In the application of cybernetics to radiation therapy the following are considered necessary: (1) the development of theoretical problems (study of the results of the cybernetic approach to physiology, pathophysiology, and diagnostic medicine); (2) the development of standardized methods for evaluating the treatment results in different diseases and for quantitatively determining radiation reactions and radiosensitivity of tissues; (3) solution of organizational problems (collection of information, establishment of standard terminology, etc.); and (4) decisive development of the group method for study of each specific patient by a group of specialists (physicians and physicists). The latter has already been included in practice. P.V.E.

N64-20948 Joint Publications Research Service, Washington, D.C.

CLASSIFICATION OF RADIATION SICKNESS

G. D. Baysogolov and A. K. Gus'kova *In its* Studies in Med. Radiol. 4 May 1964 p 47–57 refs (See N64-20943 14-16) OTS: $1.50

In the classification of both chronic and acute radiation sickness, it is necessary to distinguish the following: (1) the full-fledged clinical syndromes whose occurrence is basically conditioned by the action of whole-body external radiation or by the intake of isotopes into the body, which are rapidly and uniformly distributed through all the organs and tissues; and (2) clinical syndromes with predominant involvement of various organs and systems as the result of their selective irradiation with isotopes with a distinct organotropism and selectivity of deposition or from the action of local external penetrating radiation. In the development of chronic radiation sickness, from continuing whole-body radiation effects, and after its cessation, it is possible to distinguish the following periods: (1) formation of chronic radiation sickness or chronic radiation sickness proper; (2) recovery; and (3) the sequelae of chronic radiation sickness.

N64-21043 Joint Publications Research Service, Washington, D.C.

STRUCTURAL CHANGES IN THE VISUAL ANALYSOR OF MONKEYS AFTER EXTIRPATION OF THE CERVICAL LOBES

L. V. Koroleva 27 May 1964 8 p refs Transl. into ENGLISH from Byul. Eksperim. Biol. i Med. (Moscow), no. 12, 1963 p 97–100

(JPRS-24800; OTS-64-31347) OTS: $0.50

The visual region—Broadmann's areas 17, 18, 19 with underlying white matter—was surgically removed from hamadryas baboons at the age of 4 days, of 1 1/2 months, and of 3 years. The animals were killed after 10 months and after 1 1/2 years following surgery. The brains of the animals were stained by Nissl's and Spielmeyer's methods. Results indicate: (1) Segments of the brain remaining after surgery did not show any morphological regeneration of the extirpated occipital lobes. (2) The cortical visual fields were vertually removed from all three animals. (3) The external geniculate bodies underwent total cellular degeneration with a reduction in the number of nuclei following extirpation of the occipital lobes in an adult baboon. In the external geniculate body of baboons operated on at the age of 4 days and of 1 1/2 months, undegenerated nerve cells were preserved; the nuclei were of the same size as in the control animals. (4) The degeneration of nerve cells with replacement by proliferating glial cells was observed in the lateral and lower segment of the pulvinar of the optic thalmus. (5) The degeneration of associative pathways was traced to remnants of the visual fields, the middle temporal gyrus, the gyrus cinguli, and the hippocampal gyrus. (6) Degeneration was observed, following unilateral extirpation of the occipital lobes, in the optic tract on the same side. (7) The anterior tubers of the quadrigemina remained intact in all three animals. I.v.L.

N64-21056 Nuklearni Institut Josef Stefan, Ljubljana (Yugoslavia)

STUDIES ON THE NITROGEN METABOLISM IN FROG LIVER AFTER WHOLE-BODY IRRADIATION. I. NATURE OF THE NITROGEN COMPOUNDS EXCRETED FROM THE ISOLATED LIVER OF NON-IRRADIATED AND IRRADIATED FROGS

M. Furlan, N. Antonijević, and D. Lebez Dec. 1963 13 p refs Submitted for Publication
(NIJS-R-421)

Perfused frog liver excretes increased amounts of protein and nonprotein nitrogen after whole-body irradiation of frogs. Paper chromatographic analysis showed that amino acids excreted from the irradiated and nonirradiated frog livers are qualitatively similar, though their amounts are increased with irradiation. The amino acid composition in the perfusate is very similar to the composition of the hydrolysates of frog serum and liver tissue proteins. C^{14} labeled frog serum proteins are not the main source of increased amino acid excretion in the liver after irradiation. Whole-body irradiation of frogs causes an enlargement of the livers with no significant differences in the liver composition. The mechanism of this change is discussed. Author

N64-21078 Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.

THE EFFECTS OF AMBIENT PRESSURE ON THE TOLERANCE OF MICE TO AIR BLAST

Edward G. Damon, Donald R. Richmond, and Clayton S. White Mar. 1964 33 p refs Presented at the Symp. on Biol. Effects of Blast and Shock, Albuquerque, N. Mex., 20 Apr. 1963
(Contract DA-49-146-XZ-055)
(DASA-1483; AD-600551)

Mice were exposed to overpressures of long duration in the expansion chamber of an air-driven shock tube inside which the initial, preblast pressures were varied over sixfold. When the animals were held at the initial pressure for 1 hour following the blast, before being returned to the ambient pressure of the laboratory, tolerance values, expressed as LD_{50}–1-hour gage pressures, increased fourfold; they were 20.3, 31.0, 44.5, 55.4, and 91.8 psi for initial pressures of 7, 12, 18, 24, and 42 psia, respectively. When animals were returned to ambient level soon after blast exposure, the LD_{50} pressures were lower than the above values for initial pressures greater than ambient, and higher for initial pressures lower than ambient. The feasibility of scaling biological blast effects as a function of altitude was discussed, and one approach suggested by available empirical data was regarded as a promising, but tentative, procedure. Author

N64-21094 School of Aerospace Medicine, Brooks AFB, Tex.

EFFECTS OF HIGH CONCENTRATIONS OF CARBON DIOXIDE AND DIET ON URINARY EXCRETION OF STEROIDS AND CATECHOLAMINES

Frode Ulvedal, R. G. Cutler, and B. E. Welch Aug. 1963 16 p refs
(SAM-TDR-63-63; AD-419149)

Air Force pilots were exposed to inspired tracheal P_{CO_2} of 21 mm Hg (BTPS) at 700 mm Hg and 200 mm Hg cabin pressure. Each exposure was of 4 days' duration and was preceded in each case by a control period of low CO_2 also of 4 days' duration at the equivalent cabin pressures. During the entire experiment, including pre- and postexperiment control periods, the subjects were given a special liquid diet. The effects of CO_2 and diet on the endocrine functions were studied by determining the urinary excretion of epinephrine, norepinephrine, 17-OHCS, and corticosterone-like hormones. The CO_2, both at ground and at simulated altitude, increased the excretion of epinephrine, norepinephrine, and corticosterone-like hormones. CO_2 at simulated altitude had a stronger effect than at ground level. The special liquid diet caused increased excretion of epinephrine; the excretion of the other three hormone groups decreased. Author

N64-21101 School of Aerospace Medicine, Brooks AFB, Tex.

CORTICOSTEROIDS IN HUMAN PAROTID FLUID FOLLOWING ORAL HYDROCORTISONE DOSAGE

Ira L. Shannon and Fred H. Katz Apr. 1963 7 p refs
(SAM-TDR-63-12; AD-403380)

A single 20-minute parotid fluid sample was collected prior to, and six 20-minute samples were collected subsequent to the oral administration of 50 mg of hydrocortisone to 30 healthy young adult males. Blood was drawn before dosage and 2 hours thereafter. The following conclusions were drawn: The serum-free 17-OHCS increase after dosage was highly significant. Hydrocortisone did not exert a significant effect on parotid fluid flow rate. A highly significant increase in parotid fluid-free 17-OHCS levels was found in the 40- to 60-minute sample. A significant response was elicited in all subjects within 2 hours. Author

N64-21125 Joint Publications Research Service, Washington, D.C.

INFORMATION PROCESSES IN THE LIGHT OF BIOCYBERNETICS

S. N. Braynes and A. I. Suslov 28 May 1964 12 p refs Transl. into ENGLISH from Eksperim. Khirur. i Anesteziol., (Moscow), v. 9, no. 2, Mar.–Apr. 1964 p 13–18
(JPRS-24816; OTS-64-31355) OTS: $0.50

A hypothesis for one of the possible mechanisms of elementary information processes in living organisms is presented. According to this hypothesis, transmission of information in biological systems is based on interaction between macromolecular structures and the electromagnetic field. Problems of transmission and encoding of information on the level of biological macromolecules are being investigated by modern molecular biology. Evidence that transmission and processing result from the collective interaction of molecular complexes is presented. Such interaction is divided into elementary acts of transmission and processing of information for a more detailed analysis of control processes. R.T.K.

N64-21215 California U., Los Angeles. School of Medicine

EXPERIMENTAL BASIS OF QUANTITATIVE RADIORENOGRAPHY FOR EVALUATING RENAL ISCHEMIA

Earl K. Dore, G. V. Taplin, D. E. Johnson, and A. T. Crockett May 1964 36 p refs
(Contract AT(04-1)-GEN-12)
(UCLA-12-523)

A quantitative expression of the slopes of a renogram's second segments is shown experimentally to be a reliable measure of fractional renal blood flow. Most patients with unilateral renal artery occlusive disease and hypertension have blood flow values to the involved kidney that are clearly below the normal range. A critical degree of renal artery constriction must be exceeded before blood flow falls or renogram abnormalities appear. When renal artery constrictive disease is bilateral, fractional flow to each kidney may be normal even though both kidneys are definitely ischemic. To quantitate ischemia, a separate estimate of total flow is required. Radioassay of the renogram test agent (iodohippurate I^{131}) in the urine collected exactly 15 minutes after injection is a simple way to obtain this information. Author

N64-21282 Joint Publications Research Service, Washington, D.C.

CAUSE OF THE DECREASE IN THE NATURAL RESISTANCE OF IRRADIATED ANIMALS TO LIVE BRUCELLOSIS VACCINE

Z. V. Shevtsova 3 Jun. 1964 10 p refs Transl. into ENGLISH from Zh. Microbiol., Epidemiol., i Immunobiol. Moscow, v. 41, no. 4, Apr. 1964 p 100–105

(JPRS-24896; OTS-64-31389) OTS: $0.50

The factors that play a leading role in the decrease observed in the resistance of irradiated animals to the vaccine strain of Brucella were investigated. An increase in mortality was observed when irradiated animals were given a live or heat-killed vaccine culture of Brucella and/or the endotoxin extracted from it. The extent to which the animals were infected with Brucella of the vaccine strain did not increase with time, and the residual virulence of the microbes was not intensified. An increase in sensitivity to Brucella endotoxin was found to play the leading role in reducing the resistance of irradiated animals to vaccine strain *Br. abortus* No. 19-BA. R.T.K.

N64-21285 Joint Publications Research Service, Washington, D.C.

COURSE OF ASEPTIC INFAMMATION OF THE CORNEA UNDER THE INFLUENCE OF β-PARTICLES FROM RADIOACTIVE THALLIUM (Tl^{204})

S. D. Denisyuk 4 Jun. 1964 10 p refs Transl. into ENGLISH from Med. Radiol. (Moscow), v. 9, no. 4, Apr. 1964 p 41–46

(JPRS-24936; OTS-64-31409) OTS: $0.50

The purpose of the investigation was to study the effectiveness of the action of various dosages of beta radiation from Tl^{204} on the course of aseptic inflammation of the rabbit cornea. It was concluded that: (1) The use of small doses of Tl^{204} radiation is an effective method of treating aseptic inflammation of the rabbit cornea as induced by injection of an emulsion of gelatine with turpentine into the cornea. (2) Irradiation in single doses of 50 and 75 rad at intervals of 48 hours yields better results than daily irradiation in single doses of 25 rad. The total dose in 50-rad irradiation is the least effective, although the duration of the healing period is somewhat greater for this method than in irradiation with individual doses of 75 rad. (3) Irradiation of the cornea with Tl^{204} has no influence on the qualitative and quantitative composition of the blood within the individual and the total dose limits used. (4) The curtailment of the period of emigration of leucocytes and cast off epithelium under the influence of irradiation indicates the anti-inflammatory action of Tl^{204}. N.E.A.

N64-21288 Joint Publications Research Service, Washington, D.C.

STRESS AND FATIGUE UNDER CONDITIONS OF ISOLATION FROM EXTERNAL STIMULI

F. D. Gorbov, V. I. Myasnikov, and V. I. Yasdovskiy 5 Jun. 1964 12 p refs Transl. into ENGLISH from Zh. Vysshei Nervnoi Deyatel'nosti (Moscow), v. 13, no. 4, 1963 p 585–592

(JPRS-24961; OTS-64-31422) OTS: $0.50

Experiments were conducted in which a man was confined to a small, especially equipped chamber for 10 to 15 days. Various sequences of tests to determine causes and degree of stress and fatigue were administered. These investigations showed that extreme restriction of general afferentation exercises a substantial influence on the subjects. The neuropsychological functional shifts were dissimilar at different stages of the experiment. Complex recording of psychological and physiological indicators enables determination of qualitative peculiarities of these shifts and, in particular, determination and differentiation of states of stress and fatigue. Monotony of the environment, lack of external impressions, and solitude emerged as factors of independent significance as conditions and causes of development of stress and fatigue. This indicates not only the necessity but also the possibility of preventing these states, on the basis of rational stimulation for the optimal interaction of afferent systems. D.E.W.

N64-21289 Joint Publications Research Service, Washington, D.C.

BIONICS, ITS METHODS AND RESULTS

G. B. Linkovskiy and S. I. Smyglyy 5 Jun. 1964 12 p Transl. into ENGLISH from Priroda (Moscow), no. 3, 1964 p 52–58

(JPRS-24971; OTS-64-31428) OTS: $0.50

The scientific discipline of biological cybernetics is called bionics. Bionics is concerned with studying biological processes for the purpose of using the information to improve old techniques and to devise new techniques. The following topics are discussed: (1) the growing realignment of biology and technology; (2) biological methods of orientation and their engineering models; (3) study of animal sense organs; (4) the brain and its technical models; (5) reliability of the performance of the main brain elements; and (6) the future of bionics in biology and technology. R.T.K.

N64-21311 Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.

THE DESIGN AND FABRICATION OF A MASK AND HELMET FOR CHIMPANZEE RESPIRATORY RESEARCH

Thomas L. Gleason III, Edward C. Dittmer, and Robert Mc Guire Wright-Patterson AFB Mar. 1964 34 p refs

(ARL-TDR-64-3; AD-433642)

This report describes the successful development of a mask and helmet that can be used to measure chimpanzee respiratory parameters for basic physiological and environmental research. A short description of the problems associated with adapting a chimpanzee to the mask and helmet are noted.

Author

N64-21346* Cedars of Lebanon Hospital, Los Angeles, Calif. Inst. for Medical Research

MEASUREMENT OF ISOMETRIC CONTRACTION AND EJECTION TIME BY THE VIBROCARDIOGRAM

Clarence M. Agress, Stanley Wegner, Daniel J. Bleifer, Harley M. Estrin, Kenneth Schroyer, et al Repr. from Am. J. Cardiology, v. 13, no. 3, Mar. 1964 p 340–348 refs

(Contract NsG-289)

Determination was made of the correlation between intracardiac pressure phenomena and the externally recorded vibrocardiogram in an anesthetized dog. Measurements obtained by intracardiac pressure pulses compared to those obtained by the vibrocardiogram demonstrated a mean time difference of 0.001 sec for isometric contraction and 0.004 sec for ejection. Other indirect methods of estimating isometric contraction and ejection were evaluated, and all methods contained theoretical and practical sources of error. Study of the vibrocardiogram for the measurement of these intervals indicates the practical advantages and greater accuracy of this technique. A.W.

N64-21353 Cornell U., Ithaca, N.Y.

PLANT STUDY; EFFECT OF TEMPERATURE, MOISTURE AND LIGHT ON THE COMPOSITION OF PLANTS GROWN BY USE OF ION EXCHANGE RESINS AS MEDIA Final Report, 1 Mar. 1962-1 Mar. 1963

J. E. Dawson 19 Jul. 1963 25 p refs

(RADC-TDR-63-183; AD-411119)

A technique suitable for measurement of atmospheric contamination of plants was worked out and tested. The growth media used consisted of a mixture of cation and anion resins, the composition of which was adjusted by use of the Donnan theory so as to provide a solution composition satisfactory for plant growth. Water was supplied by use of a glass wick. The test experiment involved three levels each of light, temperature, and water use. The growth period was 21 days. Plant foliage was analyzed for F, Cl, S, Cs, Li, Rb, Al, and B. The levels of contamination required for detection by this technique vary as follows: Li<Rb<F<Al<B<Cl<S. Author

N64-21388 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADIOELECTRONICS IN BIOLOGY [RADIOELEKTRONIKA V BIOLOGII]

L. B. Kaminir 21 Jan. 1964 83 p Transl. into ENGLISH of a Russian Brochure Moscow Gos. Energ. Izd., 1962 p 1–56
(FTD-TT-63-830/1+2+4; AD-433156)

The following topics are included: (1) the recording of biopotentials—sources of biopotentials, features of amplifying the bioelectric potentials, symmetric and unsymmetric amplification circuits of bioelectric potentials, amplifiers with capacitive coupling between stages, amplifiers with resistance coupling between stages, and obtaining a high input resistance in bioelectric amplifiers; (2) voltage sources for acting on living tissues (stimulators)—basic features of stimulators and stimulator circuits; and (3) use of radio electronics in biologic analysis—scanning microscopy, scanning systems, basic units of a scanning microscope, prospects of automating biologic analysis, and automation of blood analysis. R.T.K.

N64-21433 Sawyer (A.J.) Co., Inc., Strykersville, N.Y.

CIRCULATING DEVICE FOR CLOSED CIRCUIT RESPIRATORY SYSTEM [Final Report] Apr. 1962–Nov. 1963

Charles C. Jennings Wright-Patterson AFB, Ohio, Feb. 1964 23 p refs
(Contract AF 33(657)-9019)
(AMRL-TDR-64-8; AD-600467)

This report covers one type of circulating device for use in a closed-circuit respiratory system. Circulation is required in a closed system to remove carbon dioxide, add oxygen, remove moisture, and cool recirculating gases. The device is a single-stage, centrifugal-type blower capable of discharging 12 cfm of oxygen against a back pressure of 25 in. of water. It is powered by a 28-v d.c. motor. Power supply is a silver cell battery. Flow control is maintained electrically by a rheostat. Author

N64-21480 Joint Publications Research Service, Washington, D.C.

TISSUE MECHANISM ON ADAPTATION OF ANIMALS TO A REDUCED OXYGEN CONTENT IN THE ENVIRONMENT

N. A. Verzhbinskaya 8 Nov. 1962 20 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR (Moscow), no. 3, 1962 p 430–442
(JPRS-16105) OTS: $1.60

In an investigation of the acclimatization process of animals to hypoxia, the results of a study of the rate of turnover of adenosintriphosphoric acid (ATP) in the brain in vivo and of the permeability of the hematoencephalic barrier in 11 generations of rats born, bred, and reproducing in a hypoxic medium containing 10.5- to 11-percent oxygen are presented. The period of true acclimatization was found beginning with the eighth generation of rats living in a hypoxic medium. By this period, the ability to more efficiently and economically utilize the energy of oxidative metabolism is elaborated. The increased rate of oxidative phosphorylation in the brain tissue probably occurs because of a greater conjugation of oxidation with phosphorylation. N.E.A.

N64-21481 Joint Publications Research Service, Washington, D.C.

GEOCHEMICAL ECOLOGY

V. V. Koval'skiy 8 Jun. 1964 21 p Transl. into ENGLISH from Priroda (Moscow), no. 3, 1964 p 44–51
(JPRS-24978; OTS-64-31432) OTS: $0.50

Geochemical ecology studies the interrelationships of living organisms with geochemical environmental factors. The extent of trace elements accumulation by organisms and of metabolism in organisms is determined not only by the geochemistry of the environment and the biological condition of the organism but also by the character of the food chains, or nutrition chains, and their individual links specifying the biochemical pathways taken by trace elements in the biosphere. The biological role of trace elements and their participation in intermediate metabolism are discussed. Included, also, is a schematic map of regionalization. N.E.A.

N64-21482 Joint Publications Research Service, Washington, D.C.

STUDIES IN SYNTHETIC ELECTROCARDIOLOGY

Z. L. Dolabchyan 10 Jun. 1964 37 p Transl. into ENGLISH of selected portions of the book "Sintetich. Elektrokardiologiya" Yerevan, 1963 p 339–350, 366–367, and 407–411
(JPRS-25015; OTS-64-31450) OTS: $1.00

The aim of synthetic electrocardiology is to unify and synthesize data obtained by different methods and to compile these data to obtain a general concept of the functional and anatomical condition of the heart. A rough scheme is presented that gives an appraisal of and significance of each synthetic electrocardiologic method used in determining one or another heart condition. Only the systolic portion of the cardiac cycle is considered in discussing the pathopsychological conditions of the heart. N.E.A.

17 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and materials fabrication, handling and inspection. *For related information see*: 06 Auxiliary Systems.

N64-20809 Joint Publications Research Service, Washington, D.C.

"SQUEEZE" CASTING OF THIN-WALL PARTS

M. N. Galkin and E. S. Stebakov 26 May 1964 24 p refs Transl. into ENGLISH from Tr. Mosk. Aviats. Tekhnol. Inst. (Moscow), no. 58, 1963 p 5–20
(JPRS-24771; OTS-64-31337) OTS: $0.75

Casting by squeezing not only makes it possible to fill slot channels to a great depth with metal, but it is also a new technological process for manufacturing high-quality, large-dimension, thin-walled castings. The capacity for filling of the form during squeezing depends very little on the thermal-physical properties of the metal and form. Panels poured by

squeezing have high mechanical properties, solid homogeneity, a fine-grained structure, and a smooth surface. R.T.K.

N64-20868 Gt. Brit. Ministry of Aviation, Mottingham Technical Information and Library Services

PARAMETRIC RESONANCE IN A LOADED HORIZONTAL SHAFT MOUNTED IN A BEARING WITH A RADIAL CLEARANCE [O VOZNIKNOVENII PARAMETRICHESKOGO RESONANZA GORIZONTAL'NO RASPOLOZHENNOGO VALA S GRUZOM, IMEYUSHCHEGO PODSHIPNIK S RADIAL'-NYM ZAZOROM]

L. Y. Banakh and F. M. Dementberg Apr. 1964 8 p ref Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk: Mekh. i Mashinostr. (Moscow), v. 6, 1961 p 159–162
(TIL/T-5461)

A theoretical and experimental demonstration of resonance development is discussed. The bearing is assumed slightly lubricated, or unlubricated, and in regular motion, i.e., continuous contact with the shaft. The relation of resonance to shaft speed is derived. Author

N64-20904 Pennsylvania State U., University Park Ordnance Research Lab.

A METHOD FOR THE DESIGN OF PUMPJETS

R. E. Henderson, J. F. Mc Mahon, and G. F. Wislicenus 15 May 1964 60 p refs
(Contract NOw-63-0209-c)
(NOw-63-0209-c-7; AD-439631)

The pumpjet, a hydrodynamic propulsor, is similar to a conventional propeller rotating within a duct or shroud. The shroud permits the flow velocity through the rotor to be controlled more or less independently of the velocity of the vehicle. For certain applications, the pumpjet can be designed to have better cavitation characteristics than an open propeller; alternatively, the pumpjet can be made smaller than the conventional propeller, to reduce the weight of the propelling machinery. The pumpjet may be designed on the basis of knowledge and experience gained from axial-flow compressors and pumps. The meridional flow within the shroud is assumed to be axially symmetrical. The flow through the vane system is considered, with certain restrictions, to be cylindrical. Although axial-compressor data can be used for the blade design, blade profiles suitable for compressors are not suitable for hydrodynamic propulsors because of the stringent requirements regarding cavitation. A quasi one-dimensional method of blade design is described that uses compressor data but still meets the cavitation requirements. Problems of shroud design, skewed vanes, unsteady force action, and boundary-layer intake are discussed. Author

N64-20908 Pratt and Whitney Aircraft, East Hartford, Conn.

RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE. VOLUME I: FORGING OF FRONT AND REAR CLOSURES Final Technical Report

S. Godfrey and R. Makowski 31 Oct. 1963 267 p
(Contract DA-19-020-ORD-5230)
(WAL-766.2/1-14; PWA-2267; AD-438815)

Subscale and full-scale rocket motor case closures were forged to develop economical fabrication techniques that would produce forgings with consistently high strength levels. Forgings were intended to meet a design requirement of a 180,000-psi minimum yield strength level with 4% minimum elongation. Initial evaluation of the effects of oxygen indicated that contents between 0.11 and 0.17 wt % were acceptable. Evaluation of full-scale forgings indicated, however, that parts with oxygen contents below 0.12% were not capable of attaining the 180,000- to 200,000-psi yield strength level throughout with adequate ductility. The maximum value of 0.12 wt % and a maximum of 0.17% were established on the basis of ductility deterioration. Hammer forging techniques were investigated, but the slow aging response and low ductility of the parts produced indicated that the process was not suitable for the intended application. Six front and five rear full-scale closures were forged and evaluated with two front and three rear closures being hydrostatically burst tested. Several forging techniques were developed, but the most satisfactory was found to be a three-operation technique conducted twice at 1,800° F and once at 1,750° F. The full-scale closures generally met the desired properties. Author

N64-20909 Pratt and Whitney Aircraft, East Hartford, Conn.

RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE. VOLUME II: RING-ROLLING AND FLOW-TURNING CYLINDRICAL SECTIONS Final Report

31 Oct. 1963 198 p
(Contract DA-19-020-ORD-5230)
(WAL-766.2/1-14; PWA-2267; AD-438713)

The ring rolling technique and heat treatment used before flow turning were investigated to improve the quality of the flow-turning blanks. A solution treatment was developed, considerably improving the ductility and structure of the starting blanks. The effects of roller geometry, mandrel speed, wall thickness reduction per pass, and roller-feed rate on radial growth and local bulging were determined. Roller geometry had the most predominant effect on dimensional control, and a new roller design with parabolic contours was developed that gave positive control of diametral growth. A correlation of flow-turning parameters was developed, permitting techniques developed with subscale cylinders to be directly applied to full-scale parts. The resulting full-scale flowturned cylinders had very little diametral growth and no local bulging. Processing of the flow-turned cylinders was investigated to improve material properties. A stress-relief treatment was developed that gave 50% to 60% reduction in residual stress. Sizing of the cylinders was accomplished after stress relief and was followed by aging to the desired strength level. Author

N64-20910 Pratt and Whitney Aircraft, East Hartford, Conn.

RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE. VOLUME III. DEVELOPMENT OF WELDING PRACTICE Final Report

31 Oct. 1963 276 p refs
(Contract DA-19-020-ORD-5230)
(WAL-766.2/1-14; PWA-2267; AD-438715)

A program was undertaken to develop a technique to produce welds of a higher quality than previously obtained. Various welding practices were evaluated by bend, smooth, and notched ($K_t = 8$) tensile, and tensile G_c testing. In addition, a cyclic test technique was developed that simulated the stresses welds would be subjected to during hydrostatic pressure testing. The various welding practices included electron beam welding and single and multipass TIG (titanium inert gas) welding, using various filler materials and welding fixturing. Electron beam welding did not produce a significant improvement in weld toughness and had many disadvantages for the intended application. Multipass welding produced welds with better geometry and lower porosity than single-pass welding. The use of pure titanium rather than parent metal filler wire did not improve the weld quality. The use of copper fixturing rather than steel fixturing was found to effect further improvement in weld geometry and reduction of porosity. Author

N64-20911 Pratt and Whitney Aircraft, East Hartford, Conn.
RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE. VOLUME IV: FABRICATION AND TESTING OF FULL SCALE COMPONENTS Final Report
L Godfrey and R. Makowski 31 Oct. 1963 309 p
(Contract DA-19-020-ORD-5230)
(WALL-766.2/1-14; PWA-2267; AD-438714)

Machining techniques were developed to achieve the most rapid stock removal and the best surface finish on B-120 VCA titanium alloy full-scale component forgings in the fully aged condition. Machining times were reduced by removing surface scale before machining by blast cleaning and chemical milling. A rise-and-fall and skip-turning process was developed to replace the kellering operation for three-dimensional machining of the forward closure, which has integral thrust termination ports. Full-scale components were TIG-welded to a simple forged and machined burst-test adapter to prove the component design prior to fabricating a full-scale second stage case. All components exceeded the required 25% burst margin. Although the component designs were based on linear analysis, generally good agreement was obtained between analytical and experimental stresses. The fact that burst margins in excess of 25% were consistently achieved suggests the possibility of reducing the component wall thicknesses and thereby reducing the case weight without reducing the burst strength to a value below the required 25% margin above proof pressure. Author

N64-20968 Rome Air Development Center, Griffiss AFB, N.Y. Applied Research Lab.
ANALYSIS OF REQUIREMENTS IN RELIABILITY PHYSICS
Alfred L. Tamburrino *In its* Phys. of Failure in Electron., vol. 2 [1963] p 1–24 refs (See N64-20967 14-09)

Discussions of the role of reliability physics have begun to receive attention in the literature of reliability during recent years. Of principal concern has been the selection of a methodology and a determination of the areas of most needed research. In this study, an attempt is made to analyze the requirements of a physics of failure program. Categories of effort evaluated include electronic parts, materials, measurement techniques, and failure mechanisms. Parameters applied to these categories include part failure rates, part populations, present and proposed use, probability of improvement, and practical and economic considerations concerned with implementing the effort categories. Choice of parameters, weighting factors, and priorities is discussed. Needed areas of investigation and planning factors in failure mechanism studies are presented. Author

N64-20993 Westinghouse Electric Corp., Baltimore, Md. Air Arm Div.
SILICON SURFACE PASSIVATION: MATERIALS AND MICRO PROPERTIES
J. W. Dzimianski, E. R. Pemsel, W. J. Lytle, and S. M. Skinner *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 450–466 refs (See N64-20967 14-09)
(Supported by AF)

Angle etching is described as a technique to produce oxide removal with a suitable profile so that a traveling probe can examine the various depths of a silicon-oxide passivating layer. Various etchant compositions and concentrations were used. A frictional probe was used to examine the oxide profile prepared by angle etching. The probe was a pointed rod of tungsten, mounted so that the drag and load forces were measurable during the traverse by a transducer and by amplification. A.W.

N64-21008 * Battelle Memorial Inst., Columbus, Ohio
FABRICATION OF BERYLLIUM-CLAD TUBULAR HYPERVELOCITY IMPACT TARGETS BY GAS PRESSURE BONDING Summary Report
R. J. Diersing, H. D. Hanes, and E. S. Hodge Washington, NASA, 6 Nov. 1963 24 p
(Contract NAS3-3651)
(NASA-CR-54058) OTS: $2.60 ph

Beryllium armor was gas-pressure bonded to tubular liners to provide hypervelocity impact targets. Target size was 6 in. long by 1.220 in. in diameter of beryllium over 0.500-in.-OD Type 316 stainless steel or niobium–1% zirconium alloy having nominal wall thicknesses of 10, 25, and 40 mils. The beryllium was either hydrostatically pressed from QMV powder or fabricated from PX20 extruded and annealed beryllium tubing. Gas-pressure-bonding conditions of 1,400° F for 1 hour at 10,000 psi were used to densify and bond the beryllium to the stainless steel or niobium liner tubes. Author

N64-21029 National Semiconductor Corp., Danbury, Conn.
PRODUCTION ENGINEERING MEASURE TO IMPROVE PRODUCTION TECHNIQUES AND INCREASE THE RELIABILITY OF THE 2N328A TRANSISTOR Quarterly Progress Report No. 2, 30 Sep.–31 Dec. 1963
R. R. Rau [1963] 53 p
(Contract DA-36-039-AMC-01480(E))
(AD-439408)

The PERT scheduling of the contract was updated. Additional furnaces were procured for installation on half of the proposed new line after installation of the etch wheel. The recirculator was fully installed, evaluated, and made an operational part of the present alloy line; it produced a significant increase in test box yield and an improved performance on step-stress testing. The can welding shield was incorporated as part of the manufacturing line; preliminary evaluation by the electromechanical stress tester of an improved form of "C" bend weld shield indicated expected improvements. Some success was achieved in fabricating units by the aluminum evaporation technique, and preliminary evaluation of some of these units was made. Step-stress testing of the unimproved control 328A unit was completed as well as similar step-stress testing of units fabricated on the manufacturing line improved by the incorporation of recirculator, individual die attach, and final can weld shield modifications. Author

N64-21064 * National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ADAPTATION OF AN MoS_2 "IN SITU" PROCESS FOR LUBRICATING SPACECRAFT MECHANICAL COMPONENTS
Charles E. Vest Washington, NASA, May 1964 18 p refs Previously published as a part of AIAA Publ. CP-8; See N64-19364 12-17
(NASA-TN-D-2288) OTS: $0.50

A process was adapted to deposit a controlled thickness and a good adherent in situ MoS_2 film onto mechanical devices for spacecraft use. The devices tested were instrument bearings and gears. Results showed that the film is adherent and thickness is controllable to $\pm 50\mu$in. Also, the film has a better wear life than burnished MoS_2 powders and inorganic-bonded MoS_2 films. Author

N64-21105 CBS Labs., Stamford, Conn.
DEVELOPMENT OF PHOSPHOR SCREENS FOR HIGH RESOLUTION DISPLAY DEVICES [Final Report, Mar. 1963–Mar. 1964]

P. F. Grosso Wright-Patterson AFB, Ohio, AF Avionics Lab., May 1964 53 p refs
(Contract AF 33(657)-10632)
(AL-TDR-64-94; AD-600724)

Suitable colloidal suspensions for depositing (P-15, P-16, P-24) phosphors electrophoretically have been developed. Phosphor screens (4-in. diam) with resolutions exceeding 80 line pairs per millimeter have been deposited cataphoretically on glass, using intermediate zinc and magnesium coatings, which were subsequently removed by physical or chemical means. Stable P-24 suspensions have been developed that can be elutriated for over 80 hours. Chemical composition and spectral-emission characteristics of the electrically deposited phosphors were found to be similar to the starting material, indicating that no changes were caused by the deposition process. Qualitative spectrometer and quantitative efficiency measurements indicate an increase in radiant efficiency for cataphoretic P-16 screens under electron excitation at low current densities. Electrical measurements also indicate that the mechanism of emission from cataphoretic P-16 screens is different from settled P-16 screens and from other cataphoretic screens such as P-15 and P-24. Author

N64-21119 United Aircraft Corp., Broad Brook, Conn. Hamilton Standard Div.
ENHANCED MICRO-MODULE INTERCONNECTIONS PRODUCTION ENGINEERING MEASURE. AN HERMETIC PACKAGING SYSTEM FOR THE INTEGRATION OF MICRO CIRCUITS Second Quarterly Report, 1 Oct.-31 Dec. 1963
G. F. Lang and D. J. Garibotti 4 Jan. 1963 75 p refs
(Contract DA-36-039-AMC-03620(E))
(SCL-7686; HSER-2858; AD-432492)

The enhanced micromodule interconnections program is comprised of the preproduction effort, tooling, and pilot line and production run. Considerable effort was directed toward the evolution of previously developed processes into manufacturing techniques. In addition, electrical testing procedures were compiled and the test circuits assembled and checked out. Twenty solid-state microcircuit wafers, each provided with two integrated circuits, were assembled, tested, and submitted as samples. Several microwafer stack–header transfer wafer assemblies were fabricated, and provided with microwafers with suitably shorted terminations to permit weld resistance monitoring during vibration to detect any potential open circuits. The majority of the machines required for the establishment of the pilot line were designed, and are being fabricated and assembled. A wired electronic programer for the automatic electron beam welding of the copper ribbons and hermetic sealing of the structure was built and successfully tested.
Author

N64-21121 Mechanical Technology, Inc., Latham, N.Y.
ELASTOHYDRODYNAMIC LUBRICATION – EXPERIMENTAL INVESTIGATION
F. K. Orcutt 27 Feb. 1964 26 p refs
(Contract Nonr-3729(00) FBM)
(MTI-64TR6; AD-432340)

The overall objective of this program is to improve the life, reliability, and load capacity of concentrated contact machine elements, such as rolling-element bearings, gears, and cams. The chosen means of accomplishing this objective are to investigate the fundamental process of lubrication in concentrated rolling–sliding contacts and to attempt, wherever possible, to relate the findings to the practical aspects of bearing, gear, and cam performance. Measurements of several of the important variables of the load zone of the rolling–sliding disk apparatus were made. Measurements of the temperature of the surface as it moves through the load region were obtained for light to moderate loads with slip ratios up to about 25 percent, using improved vapor-deposited thermocouples and the rolling-disk apparatus. Preliminary attempts were made to obtain pressure measurements in the load region using deposited-manganin wire transducers. R.T.K.

N64-21146 Shell Development Co., Emeryville, Calif.
BEARING LUBRICATION UNDER SEVERE CONDITIONS Final Report, 1 Apr. 1963-31 Mar. 1964
J. B. Accinelli, W. M. Widlund, and W. W. Kerlin 30 May 1964 68 p
(Contract NOw-63-0466-c)
(S-13918; AD-440305)

The studies include a realistic evaluation of several lubricants in a 35-mm ball bearing rig operating at severe conditions of speed (40,000 rpm), load (400-lb thrust), and temperature (400° to 800° F). The lubricants tested were a highly refined mineral oil, a MIL-L-7808E lubricant, a MIL-L-9236B lubricant, and a polyphenyl ether (mixed 5P4E) lubricant. All valid tests were terminated because of lubricant consumption rather than by bearing distress. The best performance was obtained with the 5P4E at 600° F (66 hr), whereas, at 800° F, operation with this lubricant became critical. For a system that fails by loss of lubricant, two equations were derived that relate initial lubricant charge, termination lubricant charge, lubricant recovery rate, and lubricant flow rate with total operating time and number of lubricant passes. The experimental values of time and number of passes for the current tests are in excellent agreement with values predicted by the derived expressions. Author

N64-21147 Ampex Corp., Redwood City, Calif.
AN INVESTIGATION OF SELF-ACTING FOIL BEARINGS
Joseph T. Ma Mar. 1964 41 p refs
(Contract Nonr-3815(00))
(RR-64-3; AD-600657)

Experimental results on the interior and exit region film-thickness measurements of self-acting foil bearings are presented and discussed. These measurements were made with capacitive sensors and conductive foils. The measured and predicted values agree very well within the range of nondimensional parameters—h_o/R, from 10^{-4} to 10^{-3}; and, $T/\mu U$, from 10^5 to 10^6. Empirical expressions for predicting the constant and minimum film thickness applicable beyond these ranges are also presented. They are valid within the range of h_o/R from $5(10)^{-5}$ to 10^{-2} and $T/\mu U$ from 10^4 to 10^6. The validity of a growing sinusoidal film thickness in the exit region first predicted by Gross is evidenced from the photographs. The measured wavelengths checked with Barlow's calculated values within 6%. For a constant relative velocity, the effect of increasing tension is to decrease the film thickness, whereas for a constant tension, the effect of increasing speed is to increase the film thickness. The effect of gas compressibility becomes important for high relative velocity, and the effect of surface roughness greatly influences either the predicted or measured values for thin film thickness. Author

N64-21172 International Resistance Co., Philadelphia, Pa. Documented Reliability Div.
PRODUCTION ENGINEERING MEASURE FOR HIGH RELIABILITY, FIXED, FILM, PRECISION RESISTORS Fourth Quarterly Progress Report, 1 Oct.-31 Dec. 1963
Richard C. Wagner [1963] 47 p
(Contract DA-36-039-AMC-01461(E))
(AD-432926)

The small spiral end-skip evaluation progressed to where units were placed on life test. Although no detrimental performance effects were noted, end skips contributed to yield losses because they were out of tolerance. The initial termination width experiments were completed, and new limits for acceptable termination width were established. Ceramics were stroked with the termination masks to intentionally generate a current reject type; this type of defect was detrimental. Ceramics were rubbed with ruby-tip tweezers to generate a current defect type that occurred at termination inspection; this reject mode was legitimate. Frit run on film and foreign marks from subassembly data were analyzed; these are not legitimate reject modes. Foreign matter was a legitimate reject mode. First dye leak was eliminated from the XLT process. Post seal inspection and second dye leak detected all of the units previously rejected during the first dye leak test. Designs were completed for the subassembly machine, termination inspection machine, and sequential glass sealing machine. The bellows lead assembly fixturing was simplified and made more efficient, eliminating one complete handling operation. Matrix life testing of units from the helium–nitrogen study, and ceramic evaluation showed no adverse results. Author

N64-21223 Mechanical Technology, Inc., Latham, N.Y.
A NUMERICAL SOLUTION TO THE THERMAL-ELASTOHYDRODYNAMIC LUBRICATION OF ROLLING AND SLIDING CYLINDERS
H. S. Cheng 25 Feb. 1964 98 p refs
(Contract Nonr-3729(00) FBM)
(MTI-64TR7; AD-432339)

Existing isothermal theories of elastohydrodynamic lubrication of rollers are extended to include the effects of temperature in the fluid and in the solids due to heating from rolling, sliding, and compression of the lubricant. The two-dimensional finite difference method has been used in calculating the temperature in the fluid using local pressure–temperature-dependent viscosity. Both the compressibility effect and the heat from compression of the lubricant are considered in the solution of the Reynolds and the energy equation. Author

N64-21227 Sprague Electric Co., North Adams, Mass.
PRODUCTION ENGINEERING MEASURE FOR COLUMBIUM CAPACITORS First Quarterly Report, 26 Jun.–26 Sep. 1963
J. H. D. Folster, E. E. Holley, A. Whitman [1963] 13 p
(Contract DA-36-039-AMC-01468(E))
(AD-433092)

Three approaches are being studied. The effect of the amount of oxygen present in a columbium pellet before anodization on the quality of the finished capacitor has been investigated and found to be negligible. Another investigation revealed that a definite relationship exists between electrolyte composition and percent dissipation factor and leakage current. Study also resulted in an optimum reanodization voltage for the 35 v rating, and it indicated a relationship between the composition of reanodization electrolyte and leakage current levels on finished capacitors. The present anodization temperature range and the present electrolyte rinse times are satisfactory. A new method of MnO_2 deposition has been developed. The reanodization tank has been redesigned, and an improved aging facility has been established. Seventeen experimental runs of 22 μf-35 v capacitors have indicated a progressive lowering of leakage current and percent dissipation factor levels. Author

N64-21236 California U., Berkeley. Inst. of Engineering Research
A FUNDAMENTAL STUDY OF THE VARIABLES ASSOCIATED WITH THE MIXING OF CERAMIC RAW MATERIALS
D. W. Fuerstenau, R. M. Fulrath, and J. A. Pask Wright-Patterson AFB, Ohio, AF Mater. Lab., Mar. 1964 106 p refs
(Contract AF 33(616)-7763)
(ASD-TDR-62-732, Pt. II; AD-439599)

This investigation showed how the amount of spinel formed by sintering alumina and magnesia powders can be used as a measure of the degree of mixing, as a model system in ceramic processing. The dry mixing of fine powders in model mixers of the barrel and V types was conducted to study various mixing mechanisms. Analysis of these data, aided by studies of the mixing of macroscopic particles, revealed the role played by the differences in density between the components of the mix. An X-ray technique was devised to examine the micromixing of fine powders in relation to the sintering of ceramic bodies. The role of electrical effects at solid–liquid interfaces in determining mutual interaction of particles in wet mixing phenomena was examined. Author

N64-21268* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
HIGH SPEED VACUUM PERFORMANCE OF MINIATURE BALL BEARINGS LUBRICATED WITH COMBINATIONS OF BARIUM, GOLD, AND SILVER FILMS
Thomas W. Flatley Washington, NASA, Jun. 1964 14 p refs
(NASA-TN-D-2304) OTS: $0.50

A retainer study that involved bearings with gold-plated balls and raceways resulted in the selection of fully machined retainers of "S"-Inconel and of silver-plated Circle "C." Bearings with these retainer types and six ball and race plating combinations of barium, gold, and silver were studied. They were run in pairs in small induction motors in a vacuum environment, with nominal test conditions of 10,000 rpm, no external loading, and an oil-free ambient pressure in the 10^{-7} torr range. Testing revealed only one bearing configuration worthy of further study, that involving gold-plated balls, silver-plated raceways, and the fully machined silver-plated Circle "C" retainer. In direct contrast the combination of silver-plated balls and gold-plated raceways gave consistently poor performance. Bearing lifetimes achieved with the other configurations, all involving barium plating, in general fell between these extremes. Author

N64-21310 Radio Corp. of America, Harrison, N.J.
PRODUCTION ENGINEERING MEASURE FOR TUBE TYPE 7587 Seventh Quarterly Progress Report, 1 Dec. 1963–29 Feb. 1964
W. Ackermann [1964] 19 p
(Contract DA-36-039-SC-86732)
(AD-600007)

Work carried out to obtain high-volume, low-cost manufacturing capability for Nuvistor tube-type 7587, by creation of several pieces of new equipment, is discussed. During this period, the main efforts were concerned with: (1) gradual integration of new equipment in the existing production line, with emphasis directed toward improving the operating efficiency of each machine; (2) completion of preproduction requirements and formulation of plans for carrying out the pilot production run. The discussion presented considers the problems encountered, the action taken, and the progress achieved in these areas. P.V.E.

N64-21376 Boeing Co., Seattle, Wash.
MANUFACTURERS' RELIABILITY DATA
B. Wilcox 7 Oct. 1963 70 p refs
(D2-22571)

This document presents reliability and operating life data. It includes pertinent descriptive data on various levels from component parts to entire systems. This listing provides data on specific hardware and therefore differs from most of the reliability data listings in which items are grouped into classes, giving an average reliability value for the entire class. The reliability portion of the data can be used for component and system comparisons, reliability analysis, design trade studies, and design reviews. The operating life data are useful in making equipment capability estimates and comparisons, planning maintenance work, and determining spares allocations. Explanation of data source, description of tabulations, and data listings are presented. N.E.A.

N64-21403 General Electric Co., Schenectady, N.Y. Schenectady Tube Operation
PRODUCTION ENGINEERING MEASURE FOR VOLTAGE-TUNABLE MAGNETRONS Sixth Quarterly Progress Report, 18 Jul.-18 Oct. 1963
E. G. Soulier 9 Jan. 1964 26 p refs
(Contract DA-36-039-SC-86722)
(AD-432271)

As a result of the investigation, a hydrogen-flashed filament will be used for this program. The preproduction run has been initiated, and results obtained thus far are given. The yields for each tube assembly are stated. Packaging assembly for two package types are discussed. Results in the quality control area on procedures and schedules are given. Author

N64-21404 Kaysam Corp. of America, Paterson, N.J.
PRODUCTION ENGINEERING MEASURE FOR MANUFACTURE OF METEOROLOGICAL BALLOONS TYPE ML-541( )/UM Seventh Quarterly Progress Report, 19 Oct. 1963-18 Jan. 1964
Murray Miner and John Kantor, ed. [1964] 16 p
(Contract DA-36-039-SC-85988)
(AD-423900)

The prime objective of this project is to establish the capability of producing the ML-541( )/UM balloon on a pilot-run basis. A second objective of the project is the development of manufacturing methods to a high level of technology. Discussed are: (1) automatic dipping machine; (2) balloon assembly machine; (3) conveyorized drying system; (4) special tooling; and (5) preproduction samples. N.E.A.

N64-21411 Rocketdyne, Canoga Park, Calif.
ROCKET ENGINE VALVE POPPET AND SEAT DESIGN DATA Technical Documentary Report, Jul. 1962-Oct. 1963
G. F. Tellier, ed. Edwards AFB, Calif., AF Rocket Propulsion Lab., May 1964 487 p refs
(Contract AF 04(611)-8392)
(R-5494; RPL-TDR-64-68; AD-600420)

A survey was made of pertinent patents, technical literature, and industry data to determine current technology levels and indicate specific areas where information was lacking or obsolete. Analytical and empirical studies were undertaken of the detail aspects of valve sealing. Test models were fabricated with particular emphasis placed on describing the resultant sealing surfaces. Leakage flow data were obtained for the near-seated condition resulting in good correlation with theoretical predictions. The stress-leakage relationship in the on-seated condition was empirically investigated as a function of surface and material variations, pressure, and fluid. The resulting information, together with inspection evidence supporting deduced test surface finish conditions, is presented. Author

N64-21463 Westinghouse Electric Corp., Elkridge, Md. Molecular Electronics Div.
PRODUCTION ENGINEERING MEASURE Second Quarterly Report, Oct. 1-Dec. 31, 1963
Hauw T. Go
(Contract DA-36-039-AMC-03617(E))
(AD-437189)

The WX-4001 was fabricated on a production scale. Pilot runs of the WM-213 AC Binary were started for evaluation studies of electrical characteristics. Two different processing techniques for the elimination of purple and black plagues are being evaluated through an extensive test cycle, incorporating accelerated mechanical and temperature storage tests. The double coating and exposure technique was evaluated and compared on a numerical basis with the conventional single-coating technique, using a capacitor check. Evaluation and data analysis of step-stress tests are progressing. Author

N64-21465* Mechanical Technology, Inc., Latham, N.Y.
ANALYSIS OF TURBULENT LUBRICATION, VOLUME 1. THE STATIC AND DYNAMIC PROPERTIES OF JOURNAL BEARINGS IN LAMINAR AND TURBULENT REGIMES Final Report
F. K. Orcutt and E. B. Arwas 20 May 1964 141 p refs
(Contract NASw-771)
(NASA-CR-54034; MTI-64-TR-19; MTI-24(1-63)) OTS: $11.00 ph

Steady-state and dynamic characteristics of two basic journal bearing geometries have been obtained both theoretically and experimentally, in laminar and superlaminar flow regimes. These data cover the ranges of eccentricity ratios up to 0.9 and of Reynolds numbers up to 13,400. Comparison of the theoretical and experimental data is presented to check the validity of turbulent lubrication theory. The parameters investigated include: steady-state load, attitude angle, film pressure distribution, fluid film stiffness, fluid film damping, and dynamic force and displacement orbits as functions of journal eccentricity and fluid film Reynolds number. Author

18 MATERIALS, METALLIC

Includes cermets; mechanical and physical properties of alloys and metals; and metallurgy. *For related information see*: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Nonmetallic; 33 Stresses and Loads; and 34 Structural Design.

N64-20785* Brookhaven National Lab., Upton, N.Y.
LIQUID-METAL CORROSION AS A SOLUTION PHENOMENON
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 21-26 (See N64-20783 14-01) OTS: $5.00

The driving force for liquid-metal corrosion is the equalization of chemical potential for dissolution of all solid surfaces in contact with the liquid. Several mass-transfer processes are required. In static systems of pure metals, the rate of dissolution decreases with time but does not become zero. In a dynamic loop with a ΔT, there is a steady-state concentration of

solute. Mass transfer is not zero, even in isothermal systems. With alloys, the solubilities of all components are not equal, although in many liquid metals they may be in the same sequence. A.W.

N64-20793* Brookhaven National Lab., Upton, N.Y.
HETEROMETALLIC PHENOMENA
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 73–74 (See N64-20783 14-01) OTS: $5.00

Mixing materials can be dangerous, since the surface of both materials would strive to become a common alloy between the two metals. The safest way to minimize problems from heterometallic phenomena is to avoid mixing alloys in a liquid-metal system unless the major metallic constituents of all alloys are known to be essentially insoluble, and unless the activities of oxygen, sodium, carbon, and hydrogen are equalized in all alloys by gettering. A.W.

N64-20799* Brookhaven National Lab., Upton, N.Y.
SPECIAL TOPICS. B: PHYSICAL PROPERTIES (EMBRITTLEMENT)
John R. Weeks *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 97–99 refs (See N64-20783 14-01) OTS: $5.00

Embrittlement occurs in specific systems having no intermetallic compounds and only low solubility of the solid in the liquid. Embrittlement is related to properties at the liquid–solid interface. Failure by liquid embrittlement may be intergranular at twin boundaries, or transgranular. It is similar to stress-corrosion cracking by aqueous solutions. A.W.

N64-20835 Hanford Atomic Products Operation, Richland, Wash. Hanford Labs.
BEHAVIOR OF CHEMICAL NICKEL PLATE ON ALUMINUM ALLOYS IN HIGH TEMPERATURE, DYNAMIC, AQUEOUS SYSTEMS AEC Research and Development Report
A. B. Johnson, Jr. Apr. 1964 36 p refs
(Contract AT(45-1)-1350)
(HW-81196) OTS: $1.00

Behavior of chemically deposited (electroless) nickel on 1,245 and 8,001 aluminum alloys was investigated in high flow (25 fps) and low flow aqueous systems at 300° and 330° C. Effects of heat treatment on corrosion properties of the nickel plate were studied. Relatively thick nickel–aluminum diffusion layers suppressed catastrophic failure of 1,245 aluminum at 330° C. Magnetic and crystalline properties of the nickel plate are discussed; behavior of exposed aluminum at defects in the nickel plate is reported. Author

N64-20843 Ladish Co., Cudahy, Wis.
DEVELOPMENT AND STATISTICAL ANALYSIS EVALUATION OF MELTING AND TRANSVERSE PROPERTIES OF HIGH-STRENGTH (H-11 TYPE) STEEL Interim Engineering Report No. 6, 1 Jan.-1 May 1964
Robert F. Zuehike and Jack A. Yoblin Wright-Patterson AFB, Ohio, ASD, May 1964 38 p
(Contract AF 33(600)-38767)
(ASD-TR-7-678 (VI); AD-600150)

Four heats of H-11 material processed by vacuum induction melt–vacuum arc remelt technique were received. Material was ordered to a specification requiring an average transverse ductility of 12% reduction of area at the 300 to 330 ksi ultimate strength level. Material was processed through complete acceptance testing and was released for continuation of billet testing and production of the selected forgings. Author

N64-20845* Naval Research Lab., Washington, D.C. Chemistry Div.
HIGH TEMPERATURE PROPERTIES OF SODIUM AND POTASSIUM Progress Report No. 9, 1 Oct.-31 Dec. 1962
C. T. Ewing, J. P. Stone, J. R. Spann, T. A. Kovacina, and R. R. Miller 20 May 1963 17 p refs
(Contract NASA-C-76320)
(NRL-5964; AD-405673)

An experimental program was in progress to measure various thermophysical properties of sodium, potassium, and their vapors at elevated temperatures. Preliminary results presented cover the following: pressure-volume-temperature data for vapor states of sodium between 960° C (1.9 atm) and 1,420° C (25.1 atm); saturated vapor pressure of sodium from 1 to 25 atm; specific heat of saturated liquid sodium from 100° to 1,170° C; and equilibrium solubilities of columbium and zirconium in liquid sodium from 802° to 1,380° C. Author

N64-20856 Solar, San Diego, Calif. Research Labs.
EVALUATION OF COATED REFRACTORY METAL FOILS Quarterly Progress Report No. 7, 1 Jan.-31 Mar. 1964
V. S. Moore and A. R. Stetson 30 Apr. 1964 135 p refs
(Contract AF 33(657)-9443)
(RDR 1325-7; AD-439971)

Included in the current program status are: (1) Receiving inspection, furnace oxidation, and environmental tests on the Boeing Disil coated Nb752, B66, C129, and D43 niobium alloys were completed. Coating performance during 2,500° F furnace oxidation testing was best on B66; however, severe crazing of the coating initiates surface oxidation after only 3 to 5 temperature cycles. (2) Evaluation of the TRW Cr-Ti-Si preliminary screening specimens of 0.006-in. Nb752, B66, and D43 alloys processed to meet a coating thickness specification is presented. (3) Diffusion studies show that a thin layer of W interposed between a straight silicide coating and a B66 alloy substrate inhibited coating-substrate diffusion up to 24 hrs at 2,500° F. (4) Data are presented on the further development of slurry-type repair coatings. (5) Experimental evaluation of nondestructive quality-control techniques for use on coated refractory-metal foils was completed. No useful correlation between oxidation failure and any of the nondestructive test methods was observed. (6) Compatibility tests of insulations (2,500° F) and superalloys (2,000° F), at 760 torr pressure, in contact with TRW Cr-Ti-Si coating on B66 were completed. (7) Results of tests at 2,500° F show that the Ti-8.5Si braze alloy exhibits excellent oxidation resistance when coated with either a straight silicide or the TRW Cr-Ti-Si coatings. I.v.L.

N64-20894 Lockheed Missiles and Space Co., Sunnyvale, Calif.
BERYLLIUM Annotated Bibliography, Oct.-Dec. 1962, Supplement III
Jack B. Goldmann, comp. Apr. 1963 58 p refs
(Contract NOrd-17017)
(SB-62-22; Rept. 3-80-63-2; AD-438176)

The following annotated bibliography covers publications released during the fourth quarter of 1962. Citations are arranged alphabetically by author under the broad subject headings of Alloys; Analysis; Applications; Bibliographies; Compounds; Corrosion; Fabrication Techniques; Joining; Mineralogy; Oxides; Powder Metallurgy; and Casting, Processing, Properties, and Miscellaneous. References to the use of beryllium fuels, nuclear reactor applications, effects of radiation, and Cu-Be alloys were omitted. Author

N64-20912 Pratt and Whitney Aircraft, East Hartford, Conn.
RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE. VOLUME V: EVALUATION OF CANDIDATE TITANIUM ALLOYS Final Report
L. Godfrey and R. Makowski 31 Oct. 1963 73 p refs
(Contract DA-19-020-ORD-5230)
(WAL-766.2/1-14; PWA-2267; AD-438716)

Two titanium alloys, Ti-6Al-6V-2Sn and Ti-15 Mo, were evaluated with emphasis placed on high-strength applications in rocket motor cases. Roll forged rings of Ti-6Al-6V-2Sn alloy were evaluated for weldability by the TIG process and the resulting weldments were tested for mechanical properties. The effects of postweld heat treatments in the aging and annealing ranges on both parent and weld metal were evaluated, and the data were used to determine the processing sequence that would produce forgings and weldments with adequate ductility while using the high-strength capability of the wrought base material. The sheets of Ti-15 Mo alloy measuring 24 by 36 by 0.079 in. were evaluated for mechanical properties in the solution-treated and in the solution-treated-and-aged conditions. The effects of aging temperature on aging response and the effect of tensile testing temperature (−40° to 400° F) on material properties after aging at 975° F were investigated. Aging response after cold rolling (35% to 75% reductions) was also determined. Solution-treated-and-aged sheet stock was manually TIG-welded, using parent metal filler material, and evaluated by bend, tensile, and cyclic testing. The majority of testing was conducted on weldments in the as-welded condition, although limited tests were conducted to investigate weld aging characteristics. Author

N64-20913 Joint Publications Research Service, Washington, D.C.
CORROSION OF TITANIUM AND ITS ALLOYS
14 May 1964 69 p refs Transl. into ENGLISH of 5 articles from Korroziya Metallov i Splavov (Moscow), 1963 p 141–193 refs
(JPRS-24602; OTS-64-31258) OTS: $1.75

CONTENTS:

1. SELF-PASSIVATION OF TITANIUM IN ACIDIC, BASIC AND NEUTRAL MEDIA N. D. Tomashov and R. M. Al'tovskiy p 1–18 refs (See N64-20914 14-18)
2. CORROSION AND ELECTROCHEMICAL BEHAVIOR OF TITANIUM AND ITS ALLOYS WITH MOLYBDENUM V. I. Kazarin and V. V. Andreyeva p 19–32 refs (See N64-20915 14-18)
3. INVESTIGATION OF THE HYDROGEN EMBRITTLEMENT OF ALPHA-TITANIUM ALLOYS DURING CATHODE POLARIZATION N. D. Tomashov, V. N. Modestova, S. T. Glazunov, E. A. Borisova, and V. L. Zotov p 33–44 refs (See N64-20916 14-18)
4. EFFECT OF DENSITY OF CURRENT ON THE HYDROGEN EMBRITTLEMENT (HE) AND CORROSION OF TITANIUM ALLOYS N. D. Tomashov, V. N. Modestov, and A. S. Anatolev p 45–53 refs (See N64-20917 14-18)
5. BEHAVIOR OF TITANIUM ALLOYS DURING CORROSION UNDER STRESS AND THEIR HYDROGEN EMBRITTLEMENT (HE) N. D. Tomashov and V. N. Modestov p 54–66 refs (See N64-20918 14-18)

N64-20914 Joint Publications Research Service, Washington, D.C.
SELF-PASSIVATION OF TITANIUM IN ACIDIC, BASIC AND NEUTRAL MEDIA
N. D. Tomashov and R. M. Al'tovskiy *In its* Corrosion of Titanium and its Alloys 14 May 1964 p 1–18 refs (See N64-20913 14-18) OTS: $1.75

It was found that the passive state of titanium in solutions of NaCl, and NaOH, nitric acid, and also in dilute solutions of sulfuric and hydrochloric acids (to 5%), exposed to an atmosphere of air, is spontaneously stable. Spontaneous stability of the passive state of titanium in solutions of hydrochloric acid of concentrations over 1% and sulfuric acid of concentrations over 0.33% is possible only in the presence of oxygen in the atmosphere and in the electrolyte. In solutions of NCl and NaOH, and also in solutions of sulfuric acid of concentrations up to 0.33% and hydrochloric acid of concentrations to 1% self-passivation of titanium is possible even in the absence of oxygen in the atmosphere and in the electrolyte. A main role in the process of oxide film formation during the self-passivation of titanium is played by the oxygen contained in the water. Author

N64-20915 Joint Publications Research Service, Washington, D.C.
CORROSION AND ELECTROCHEMICAL BEHAVIOR OF TITANIUM AND ITS ALLOYS WITH MOLYBDENUM
V. I. Kazarin and V. V. Andreyeva *In its* Corrosion of Titanium and its Alloys 14 May 1964 p 19–32 refs (See N64-20913 14-18) OTS: $1.75

Speed of corrosion of titanium and the value of anode critical current density have a definite dependence on the concentration of sulfuric acid. There are distinct ranges of concentrations in which the dependence of these values may be described by a relationship of the type $K = kX^n$; where K is the speed of corrosion, or anode critical current density; X is the concentration of acid; and k and n are constants. Speed of corrosion of titanium in passive state can be increased in the presence of ions of fluorine in solutions of sulfuric acid. It also is increased in the presence of nitric acid at temperatures not lower than 100° C. Alloys of titanium with molybdenum, having on their surface more protective film than titanium, possess higher corrosion stability than titanium. For alloys with high content of molybdenum there is a characteristic lowering of corrosion stability in ranges of positive potential over +0.2 v. Author

N64-20916 Joint Publications Research Service, Washington, D.C.
INVESTIGATION OF THE HYDROGEN EMBRITTLEMENT OF ALPHA-TITANIUM ALLOYS DURING CATHODE POLARIZATION
N. D. Tomashov, V. N. Modestova, S. T. Glazunov, E. A. Borisova, and V. L. Zotov *In its* Corrosion of Titanium and its Alloys 14 May 1964 p 33–44 refs (See N64-20913 14-18) OTS: $1.75

The kinetics of cathodic hydrogen embrittlement of titanium has been investigated, the titanium having an increased content of oxygen (0.22%) and the alloy of titanium having 4.35% Al (VT5), in a solution of 0.03 N H_2SO_4 and 0.5 N Na_2SO_4. Hydrogen embrittlement was determined by the method of vacuum annealing and metallographic analysis. It was found that, at constant current density, the quantity of hydrogen absorbed by titanium, titanium with increased content of oxygen, and by alloy VT5 was proportional to the square root of time, i.e., the process of hydrogen embrittlement proceeded according to the law of a quadratic parabola. In the investigated range of current densities of 20 to 80 ma/cm^2, the main factor controlling the process of hydrogen embrittlement is the diffusion of atomic hydrogen inside the hydride layer and metal. The speed of absorption of hydrogen by titanium decreases during an increase in its concentration of oxygen and aluminum. Author

N64-20917 Joint Publications Research Service, Washington, D.C.

EFFECT OF DENSITY OF CURRENT ON THE HYDROGEN EMBRITTLEMENT (HE) AND CORROSION OF TITANIUM ALLOYS

N. D. Tomashov, V. N. Modestov, and A. S. Anatolev *In its* Corrosion of Titanium and its Alloys 14 May 1964 p 45–53 refs (See N64-20913 14-18) OTS: $1.75

The effect of density of cathode current on the formation of a hydride layer and speed of corrosion of titanium and alloy VT5 in acid and partially in alkali media was investigated. It was found that at equal time intervals (48 hr), with an increase of cathode current, the thickness of the hydride layer on titanium increases to a certain limit ($\sim 20\mu$). At further increase of current density to over 5 to 10 ma/cm^2, in connection with saturation of external surface of hydride layer by hydrogen, the thickness of the hydride layer remains almost constant. During cathode polarization of titanium in 3N H_2SO_4 with current of constant density (8 and 20 ma/cm^2), growth of the hydride layer is a parabolic function of time. On alloy VT5, the thickness of the hydride layer, at an increase of current density in 3N H_2SO_4, increases and passes through a maximum and drops. It was shown that a decrease of thickness of the hydride layer, after a maximum, is caused by an increase of the speed of corrosion at an increase of current density (the phenomenon of a negative protective effect). Author

N64-20918 Joint Publications Research Service, Washington, D.C.

BEHAVIOR OF TITANIUM ALLOYS DURING CORROSION UNDER STRESS AND THEIR HYDROGEN EMBRITTLEMENT (HE)

N. D. Tomashov and V. N. Modestov *In its* Corrosion of Titanium and its Alloys 14 May 1964 p 54–66 refs (See N64-20913 14-18) OTS: $1.75

The prolonged effect of relatively dilute solutions of acids on alloy VT5 (5.3% and 10% HCl, 7.3% and 12.9% H_2SO_4) and titanium (10% HCl) leads to the formation of a solid hydride layer, which is visible upon examination of slides under a microscope. Tensile stress promotes penetration of hydrogen into metal under the hydride layer, separation of hydrides of titanium being chiefly at the glide planes. During corrosion under stress in these relatively dilute solutions of acids, samples of alloy VT5 containing aluminum (in contrast to titanium) rupture with comparative brittleness. In accordance with the occurrence of hydrides of titanium, fissures develop chiefly along the glide plane, maintaining on a macroscale a direction perpendicular to the stress. Rupture of samples of alloy VT5 is due basically to a decrease in the cross section of samples as a result of corrosion, and also, to the formation of fissures that accelerate the onset of rupturing. The possible mechanism of the development of fissuring and the role of aluminum are also considered. Author

N64-20919 Joint Publications Research Service, Washington, D.C.

A MODIFICATION OF ALUMINUM AND TITANIUM ALLOYS

15 May 1964 38 p refs Transl. into ENGLISH from Korroziya Metallov i Splavov (Moscow), 1963 p 194–221 (JPRS-24627; OTS-64-31270) OTS: $1.00

CONTENTS:

1. CELLULAR STRUCTURE OF THICK ANODIC OXIDE FILMS N. D. Tomashov and F. P. Zalivalov p 1–12 refs (See N64-20920 14-18)

2. THE EFFECT OF THICK-LAYER ANODIZING ON THE MECHANICAL PROPERTIES OF ALUMINUM ALLOYS N. D. Tomashov, F. P. Zalivalov, V. N. Modestova, and N. N. Ignatov p 13–18 refs (See N64-20921 14-18)

3. METHOD OF WEIGHT AND THICKNESS DETERMINATION OF ANODIC OXIDE FILMS ON TITANIUM T. V. Matveeva and V. A. Pavlova p 19–23 refs (See N64-20922 14-07)

4. INVESTIGATION OF THE PROPERTIES OF THICK ANODIC FILMS ON COMMERCIAL ALUMINUM ALLOYS N. D. Tomashov, F. P. Zalivalov, and N. N. Ignatov p 24–35 refs (See N64-20923 14-18)

N64-20920 Joint Publications Research Service, Washington, D.C.

CELLULAR STRUCTURE OF THICK ANODIC OXIDE FILMS

N. D. Tomashov and F. P. Zalivalov *In its* A Modification of Aluminum and Titanium Alloys 15 May 1964 p 1–12 refs (See N64-20919 14-18) OTS: $1.00

The main relationship determining such structural parameters of thick-layered anode films as dimension of the oxide cell (C'_{cir}) and thickness of the barrier layer, is equation: $C'_{cir}-p/2\delta = 1$, where p is the diameter of the pore. Mechanism of the formation of ordered cellular structure was established, according to which, during forming of oxide cells, not only a qualitative (change of dimensions) but also a quantitative (change of number) rebuilding of cellular structure takes place. Author

N64-20921 Joint Publications Research Service, Washington, D.C.

THE EFFECT OF THICK-LAYER ANODIZING ON THE MECHANICAL PROPERTIES OF ALUMINUM ALLOYS

N. D. Tomashov, F. P. Zalivalov, V. N. Modestova, and N. N. Ignatov *In its* A Modification of Aluminum and Titanium Alloys 15 May 1964 p 13–18 refs (See N64-20919 14-18) OTS: $1.00

The effect of anode oxidation of two aluminum alloys on their mechanical properties was investigated. Strength, with a growth of thickness of the anode film, changes insignificantly; in the beginning (to thicknesses of films of 10 to 25μ), it is somewhat increased, and then drops constantly. Increase of thickness of the anode film strongly lowers relative elongation and, especially, narrows samples due to formation of cracks in film, which appear under the influence of applied mechanical tensile stress. At further increase of thickness of film, this effect is intensified due to the appearance of cracks in anode film formed in the process of anodic oxidation. Author

N64-20923 Joint Publications Research Service, Washington, D.C.

INVESTIGATION OF THE PROPERTIES OF THICK ANODIC FILMS ON COMMERCIAL ALUMINUM ALLOYS

N. D. Tomashov, F. P. Zalivalov, and N. N. Ignatov *In its* A Modification of Aluminum and Titanium Alloys 15 May 1964 p 24–35 refs (See N64-20919 14-18) OTS: $1.00

A systematic investigation of the properties of anode films received by method of thick-layer (hard) anodic oxidation of large number of mechanically shaped and cast aluminum alloys was conducted. There are definite parameters of anode films: thickness (thickening), hardness, wear, rupturing voltage, and porosity. Of the mechanically shaped alloys, highest values of hardness and rupturing voltage were possessed by film produced on alloys. The most wear resistant were films on alloys V95, D1, AV, D16, and AM_g5VM. The lowest values, by way of separate properties, were shown by films on alloys AMts (wear), D1 (rupturing voltage), D16 (hardness and porosity). The properties of anode films on cast aluminum alloys in a number of

cases considerably differ from the properties of film produced on mechanically shaped alloys. Thus, the wear of these films is lower, and the porosity is higher than for any mechanically shaped alloy. Secondary aluminum alloy AL10V, in a number of properties of the anode film, is inferior to all other investigated alloys. From given conditions, experimental and calculated data characterizing the properties of thick-layered anode films allow selection of aluminum alloys. Vice-versa, from the selected alloy can be estimated the properties of the film produced on it. Author

N64-21003 European Atomic Energy Community, Brussels (Belgium)

INFLUENCE OF VARIOUS COLD-WORKING PROCESSES ON THE MECHANICAL PROPERTIES AND DEGREE OF DISPERSION OF SINTERED ALUMINUM PRODUCTS [EINFLUSS UNTERSCHIEDLICHER KALTVERFORMUNGEN AUF DIE MECHANISCHEN EIGENSCHAFTEN UND DEN DISPERSIONSGRAD VON SINTERALUMINIUM]

E. G. Hess Joint Nucl. Res. Center Ispra Estab. (Italy) Mater. Dept., Dec. 1963 13 p refs In GERMAN; ENGLISH summary Presented at the Meeting of the Deut. Ges. für Metallkunde, Berlin, 13 Jun. 1963

(EUR-433.d) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

As-extruded dispersion-hardened aluminum (SAP) containing 4% to 14% Al_2O_3 as the strengthening phase was cold-worked by drawing, rolling, and swaging. The maximum deformability—limited by the resistance to recrystallization—and both the influence of cold-work on the dispersion structure, and the mechanical properties, are investigated. With increasing cold-work three ranges with different deformation mechanisms were observed: (1) work-hardening of the matrix; (2) refinement of the banded structure originating from the extrusion; and (3) considerable dispersion improvement by craking and distribution of $FeAl_3$-inclusions and oxyd-agglomerates in the range of the highest reductions. Author

N64-21004 European Atomic Energy Community, Brussels (Belgium)

PHYSICAL PROPERTIES OF LIQUID METALS ON THE REGION OF MELTING- AND BOILING POINT [ZUR KENNTNIS DER PHYSIKALISCHEN STOFFEIGENSCHAFTEN VON FLUSSIGMETALLEN ZWISCHEN SCHMELZ- UND SIEDEPUNKT]

K. H. Spiller Joint Nucl. Res. Center Ispra Estab. (Italy) Heat Exchange Serv., Mar. 1964 60 p refs In GERMAN; ENGLISH summary

(EUR-599.d) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 85 Belg. Fr.

The physical properties of some important liquid metals (sodium, potassium, NaK, Pb-Bi-Eutectic and tin) are presented for the temperature range between point of fusion and boiling point. This information is taken from numerous sources of literature. A table compares properties of other metals that are not especially treated. Author

N64-21015 International Nickel Co., Inc., Bayonne, N.J. Research Lab.

THE INFLUENCE OF RESIDUAL ELEMENTS IN MARAGING STEELS

C. J. Novak and L. M. Diran 2 Jan. 1963 28 p refs Presented at 20th AIME Elec. Furnace Conf., Cincinnati, 5–7 Dec. 1962 (TP-360)

The principal alloying element ranges in 18% Ni maraging steels were formulated to provide the maximum constancy of properties consistent with commercial feasibility. Results are: (1) Aluminum in moderate amounts up to 0.15% improves the impact strength of the steels; larger amounts strengthen but have a corresponding loss of toughness. (2) Excessive carbon reacts with titanium to form titanium carbide and with molybdenum to form molybdenum carbide; these carbides weaken the alloy. (3) Sulfur is extremely detrimental. (4) The 18% maraging steels do not appear to be highly sensitive to phosphorus, antimony, arsenic, tin, lead, and bismuth; exact limits are not known. (5) Chromium, copper, and tungsten in amounts of 0.5% appear to be harmless; exact amounts are not known. I.v.L.

N64-21047 Laboratories Du Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)

SWELLING OF URANIUM Final Report

S. Amelinckx, L. Binst- P. Delavignette, J. Nicasy, and E. Ruedl (Euratom) Brussels, Euratom, Sep. 1963 39 p refs (Contract EURATOM-022-60-10-RDB)

(EUR-243.e; EURACE-371) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86

This report deals with some observations by means of transmission electron microscopy on dislocations in pure uranium, on a 1.5% chromium–uranium alloy, and on dislocations and radiation damage in platinum. These observations were performed as a preliminary study of the more complex behavior of the fission product gases formed in uranium under irradiation. In order to get a better understanding of this behavior, model-experiments were performed along the same line but on a metal of simpler crystal structure than uranium. Annealed platinum was used in the form of thin beaten foils. The annealed foils show features that are typical for a face centered cubic metal with a medium high stacking fault energy. Prismatic loops with an $\frac{a}{2}$ [110] Burgers vector result from the irradiation. Preferential loop formation is noticed at certain boundaries, in particular along coherent twin boundaries. It is noticed that for small doses dislocation loops are not distributed at random in the interior of the grains but show a tendency to be aligned. After quenching, specimens contain both cavities and loops. Author

N64-21096 Battelle Memorial Inst., Columbus, Ohio Defense Metals Information Center

THE MECHANICAL PROPERTIES OF THE 18 PER CENT NICKEL MARAGING STEELS

J. E. Campbell, F. J. Barone, and D. P. Moon 24 Feb. 1964 125 p refs

(Contract AF 33(615)-1121)

(DMIC-198; AD-600427)

This report is intended to provide as complete a background of information on the mechanical properties of the 18%-nickel maraging steels as is obtainable at the present state of development of these alloys. Since the combination of tensile properties and toughness that can be obtained with the maraging steels is higher than can be achieved with other steels by simple heat treatments, there is considerable interest in using the maraging steels for critical components such as rocket motor cases, pressure vessels, and aircraft forgings. Before these new alloys can be considered for such applications, considerable information on their mechanical properties must be collected and evaluated. This report includes information on the tensile, compressive, shear, bearing, dynamic modulus, impact, bend, fatigue, creep, and rupture properties of the 18%-nickel maraging steels and on the effect of temperature on these properties. Data for the properties of sheet, bar, and forgings, as well as data illustrating the effect of cold rolling, variation in the heat treatment, and elevated-temperature exposure also are presented. Data on the effect of specimen orientation, also

included, indicate that the ductility and toughness of specimens designed to evaluate the properties in the short transverse direction are somewhat lower than in the other directions.
Author

N64-21100 Army Materials Research Agency, Watertown, Mass. Materials Testing Lab.
MECHANICAL PROPERTIES OF COLD-DRAWN MARTENSITIC SAE 4340 STEEL ROD
Eugene Di Cesare Jan. 1964 29 p refs
(AMRA-TR-64-02; AD-600404)

In the cold drawing of steel rods, the processing conditions can have an appreciable effect on the mechanical properties. Processing variables were prior to heat treatment, consisting of a quench and temper at 1,150°, 1,000°, 800°, 500° F, or room temperature; reduction (10% to 40%); back pull (0 to 16,650 lb); drawing speed (10 to 40 fpm); and aging temperature (room or 400° F). Final rod diameter was 0.409 in. Engineering tensile, notch tensile, hardness, and true stress–true strain properties are presented. The maximum increase in engineering tensile and yield strengths was realized in the material pretempered at room temperature, drawn 10% and aged at 400° F. Yield and tensile strengths were increased from 222,000 psi to 368,000 psi and from 316,000 psi to 371,000 psi, respectively, with improved ductility. The primary effect of cold drawing, to strengthen by strain hardening, is dependent upon the pretempering temperature. An additional strengthening increment is due to aging at 400° F and appears to be essentially independent of the pretempering temperatures.
Author

N64-21157 Marquardt Corp., Van Nuys, Calif.
PRELIMINARY EVALUATION OF FOUR COLUMBIUM BASE ALLOYS FOR COATING CAPABILITIES AND MECHANICAL PROPERTIES AT ELEVATED TEMPERATURES
J. C. Reeves 18 Oct. 1963 33 p refs
(Contract AF 33(657)-10795)
(Rept. 6012; AD-421620)

Disilicide coatings were applied to columbium-alloy test panels and successfully tested at 2,700° F for 30 minutes, using an oxyacetylene torch. Short-time tensile tests at room temperature, at 1,800° F, and at 2,580° F were conducted with disilicide-coated specimens. Comparison of the test results with published data (noncoated specimens) indicated that the protective coating did not affect the base metal properties of the columbium alloys and that it afforded adequate protection against oxidizing environments. Creep and stress-rupture tests at 2,600° F, aimed at achieving 100-hr values, were also conducted. Brazing of the columbium alloys was successfully accomplished when using B-120 VCA titanium alloy; however, the disilicide coating tended to embrittle the brazed joint.
R.T.K.

N64-21165 Lockheed Missiles and Space Co., Sunnyvale, Calif.
NICKEL-IRON PERMALLOY FILMS An Annotated Bibliography [1958-1963]
Jack B. Goldmann comp. Sep. 1963 71 p refs
(Contract NOw-62-0363)
(SB-63-62; Rept. 3-26-63-6; AD-439443)

This is an annotated bibliography consisting of entries on the making of iron films, nickel films, nickel–iron, or Permalloy films by means of thermal decomposition of the carbonyls, reduction of the halides, or other methods, during the years 1958 to 1963. The use of high-vacuum techniques is omitted.
Author

N64-21182 General Electric Co., Philadelphia, Pa. Space Sciences Lab.
DEVELOPMENT OF COMPOSITE STRUCTURAL MATERIALS FOR HIGH TEMPERATURE APPLICATIONS Fifteenth Progress Report, 1 Dec. 1963-29 Feb. 1964
W. H. Sutton, J. Chorne, and A. Gatti Apr. 1964 34 p refs
(Contract NOw-60-0465-d)
(AD-439813)

Progress is summarized as follows: (1) A metal-ceramic disc was developed and used in the growth of Al_2O_3 whiskers on a small-scale continuous process. (2) A Ni-Pd alloy was selected as a matrix to be used in the study of whisker reinforcement. (3) Several mold materials were investigated for use in the fabrication of composite specimens. Fused silica was selected because of its transparency and because it can be readily formed into capillary molds for infiltrating the Ni-Pd alloy. (4) The Pt coatings were severely degraded when heated to temperatures necessary to fabricate Ni–Ni-Pd composites. For this reason several coating compositions were evaluated experimentally. The results indicate that Fernico 5 (an Fe-Ni-Co alloy) coating on the individual whiskers will withstand these higher temperatures. (5) Considerations on fabricating whisker-reinforced composites by vacuum infiltration techniques are presented. The role of metallic coatings on the whiskers is also discussed.
Author

N64-21187 Joint Publications Research Service, Washington, D.C.
STUDIES IN THE METALLURGY OF VARIOUS ALLOYS
26 May 1964 53 p refs Transl. into ENGLISH from Tr. Inst. Met. Im. A. A. Baikova, Akad. Nauk SSSR (Moscow), no. 14, 1963 p 78–89, 120–138, 147–154
(JPRS-24761) OTS: $1.50

CONTENTS:

1. ACTIVATION ENERGY AND MECHANISM OF SELF-DIFFUSION OF NICKEL A. Ya. Shinyayev p 1–11 refs (See N64-21188 14-18)

2. INVESTIGATION OF DIFFUSION PROCESSES IN BRAZING RHENIUM-COATED TITANIUM V. V. Bondarev and A. Ya. Shinyayev p 12–16 refs (See N64-21189 14-18)

3. EFFECT OF ADDITIONAL ALLOYING ON THE PROPERTIES OF MAGNESIUM-NEODYMIUM ALLOYS M. Ye. Drits, Z. A. Sviderskaya, and L. L. Rokhlin p 17–28 refs (See N64-21190 14-18)

4. RECRYSTALLIZATION OF Mg-Ce ALLOYS E. S. Kadaner and A. A. Oreshkina p 29–40 refs (See N64-21191 14-18)

5. CHANGE OF STRUCTURE AND MECHANICAL PROPERTIES OF ALLOYS BASED ON METALLIC COMPOUNDS BY THE METHOD OF SUBSTITUTING THE LOW-MELTING COMPONENT Ye. M. Savitskiy and T. A. Kim p 41–50 refs (See N64-21192 14-18)

N64-21188 Joint Publications Research Service, Washington, D.C.
ACTIVATION ENERGY AND MECHANISM OF SELF-DIFFUSION OF NICKEL
A. Ya. Shinyayev *In its* Studies in the Met. of Various Alloys 26 May 1964 p 1–11 refs (See N64-21187 14-18)
OTS: $1.50

The values of the coefficients of self-diffusion in nickel were determined. It was found that samples that had been melted in an argon atmosphere had a higher diffusion coefficient than those that were annealed at a pressure of 10^{-4} mm Hg. It was also shown that at temperatures below 1,085° C, the values of the diffusion coefficient for samples with fine grains (forged before heat treating) are always higher than for cast

samples at the same temperature. Experimental data are presented that demonstrate the existence of vacancy formation in metals. This was accomplished by investigations of various metals in the quenched state. R.T.K.

N64-21189 Joint Publications Research Service, Washington, D.C.
INVESTIGATION OF DIFFUSION PROCESSES IN BRAZING RHENIUM-COATED TITANIUM
V. V. Bondarev and A. Ya. Shinyayev *In its* Studies in the Met. of Various Alloys 26 May 1964 p 12–16 refs (See N64-21187 14-18) OTS: $1.50

The use of rhenium for the protection of titanium during high-temperature brazing was investigated. The results of mechanical and metallographic tests are given; the characteristics of the diffusion zone under various brazing conditions are presented in tabular form. The greatest mechanical strength of braze joints was obtained after brazing at 780° to 820° C with a holding time of 15 to 20 min. In this case a tensile strength of 19 kg/mm^2 is achieved with a rhenium coating 6μ to 12μ thick. At higher brazing temperatures formation of chemical compounds takes place and causes a brittle braze joint in regions of the diffusion zone as well as a sharp lowering of its strength. R.T.K.

N64-21190 Joint Publications Research Service, Washington, D.C.
EFFECT OF ADDITIONAL ALLOYING ON THE PROPERTIES OF MAGNESIUM-NEODYMIUM ALLOYS
M. Ye. Drits, Z. A. Sviderskaya, and L. L. Rokhlin *In its* Studies in the Met. of Various Alloys 26 May 1964 p 17–28 refs (See N64-21187 14-18) OTS: $1.50

The possibility of increasing the high mechanical properties of Mg-Nd base alloys by means of additional alloying with various elements was investigated. Elements were used that form a continuous series of solid solutions with magnesium or give an extensive region of solid solutions that are not altered by temperature changes (cadmium, lithium), by elements that will form a region of limited solid solutions with magnesium (aluminum, zinc, tin, bismuth, calcium, and maganese), or by elements that are practically insoluble in magnesium in the solid state (silicon, barium, nickel, and cobalt). The mechanical properties of alloys obtained by additionally alloying Mg-Nd base alloys are presented in tabular form. R.T.K.

N64-21191 Joint Publications Research Service, Washington, D.C.
RECRYSTALLIZATION OF Mg-Ce ALLOYS
E. S. Kadaner and A. A. Oreshkina *In its* Studies in the Met. of Various Alloys 26 May 1964 p 29–40 refs (See N64-21187 14-18) OTS: $1.50

The recrystallization of binary alloys of magnesium and cerium, which are the base materials for a number of heat-resistant industrial alloys, was investigated by microscopic and X-ray methods and by hardness measurements. It was found that adding minute quantities of cerium to magnesium strongly retards development of recrystallization. Increasing cerium content in the alloy retards grain growth, especially at high annealing temperatures. An increase in activation energy for recrystallization of pure magnesium containing only cerium is observed only up to 0.23% Ce. Further increase of cerium content to 1.8% does not affect magnitude of activation energy. At increased temperatures the role of recrystallization in processes of weakening Mg-Ce alloys was distinctly revealed in hardness measurements made with varying holding times and also in creep tests. The results of these tests are included. R.T.K.

N64-21192 Joint Publications Research Service, Washington, D.C.
CHANGE OF STRUCTURE AND MECHANICAL PROPERTIES OF ALLOYS BASED ON METALLIC COMPOUNDS BY THE METHOD OF SUBSTITUTING THE LOW-MELTING COMPONENT
Ye. M. Savitskiy and T. A. Kim *In its* Studies in the Met. of Various Alloys 26 May 1964 p 41–50 refs (See N64-21187 14-18) OTS: $1.50

Analysis of data shows that the ductility of the 47% Cu–53% Al alloy, substituted with 75% to 80% Sn–20% to 25% Al alloys during pressure working, more than tripled in comparison with the ductility of the respective cast alloy. Compressive strength almost doubled at an insignificant increase of hardness. For the alloy with 21% Si and 79% Al, upon substitution of eutectic with aluminum, the ductility and compressive strength were increased 1.2 times without any appreciable increase of hardness; for the alloy with 20% Ni and 80% Al, substitution of the eutectic with pure aluminum and with the 2.7% Cu+97.3% Al alloys caused no noticeable change of properties. Author

N64-21195 European Atomic Energy Community, Brussels (Belgium)
DILATOMETRICAL ANALYSES OF S.A.P. WITH VARIOUS OXIDE CONTENTS [ANALISI DILATOMETRICA DEL S.A.P. A DIFFERENTI TENORI IN OSSIDO]
G. Beghi, G. Piatti, and D. Quataert Joint Nuclear Res. Center, Ispra Estab. (Italy) Mater. Dept., Mar. 1964 24 p refs In ITALIAN; ENGLISH summary Presented at the Conf. on Non-Fissionable Metals in Nucl. Reactors, Bologna, 16–18 Dec. 1963
(EUR-1613.i) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

The average linear thermal-expansion coefficient of S.A.P. with various oxide contents was experimentally determined for the temperature ranges 20° to 100°, 20° to 200°, 20° to 300°, 20° to 400°, and 20° to 500° C. The experimental results obtained enabled the following equations to be formulated:

$$l_t = l_0(1 + 21.32 \times 10^{-6}t + 9 \times 10^{-9}t^2);$$
$$l_t = l_0(1 + 20.38 \times 10^{-6}t + 9 \times 10^{-9}t^2);$$
$$l_t = l_0(1 + 19.73 \times 10^{-6}t + 9 \times 10^{-9}t^2); \text{ and}$$
$$l_t = l_0(1 + 18.93 \times 10^{-6}t + 9 \times 10^{-9}t^2).$$

These equations, in which l_t is the length of a sample at t° C and l_0 its length at 0° C, are valid, respectively, for S.A.P. 960, 930, 895, and 865. The expansion measurements were carried out on as-extruded S.A.P. In addition, a scheme for the theoretical interpretation of results is proposed that is bound up with the hypothesis of cohesion forces existing in the S.A.P. between oxide particles and aluminum matrix. Author

N64-21196 Gt. Brit. Ministry of Aviation, Mottingham
INVESTIGATION OF THE PROCESSES OF THE OXIDATION OF IRON POWDER AT RAISED TEMPERATURES [ISSLEDOVANIE PROTSESSOV OKISLENIYA POROSHKOVOGO ZHELEZA PRI POVYSHENNYKH TEMPERATURAKH]
P. D. Dankov and N. K. Andrushenko Apr. 1964 1 p refs Transl. into ENGLISH from Zh. Fiz. Khim. (Moscow), v. 28, no. 3, 1954 p 519–524
(TIL/T-5483)

Data are given for the speed of oxidation, by the method of weighing specimens, resulting in a parabolic law. The phase composition of scale is similar to that on massive iron, and at 800° C the rates of oxidation of massive and powder iron are almost the same. The mechanism of oxidation is described. Author

N64-21226 Naval Research Lab., Washington, D.C.
METALLURGICAL CHARACTERISTICS OF HIGH STRENGTH STRUCTURAL MATERIALS Third Quarterly Progress Report
P. P. Puzak, K. B. Lloyd, R. J. Goode, R. W. Huber, D. G. Howe et al Jan. 1964 55 p refs
(NRL-6086; AD-432317)

This report covers research studies in high-strength hull structural materials. These studies included the development of preliminary flaw size–stress relationships for fracture of quenched and tempered maraging steels and of titanium alloys. Additional information was developed on the relationships of various fracture tests for these materials. Heat-treatment studies for steels and titanium alloys provided an expanded frame of reference for establishing the optimum fracture toughness level to be expected for specific levels of yield strength. The relationship of fatigue crack propagation rate to total strain range was determined for various quenched and tempered steels. Author

N64-21251* Chance Vought Corp., Dallas, Tex.
FATIGUE BEHAVIOR OF AM-350 STAINLESS STEEL AND TITANIUM-8-Al-1Mo-1V SHEET AT ROOM TEMPERATURE, 550°F AND 800°F
John J. Peterson Washington, NASA, May 1964 70 p
(Contract NASw-444)
(NASA-CR-23) OTS: $1.75

A series of fatigue tests were conducted on two candidate materials for use in a Mach 3 transport aircraft. The basic materials and typical structural joining procedures were evaluated at temperatures to 800° F. Fatigue analyses were conducted to determine the suitability of these materials under the effects of variable amplitude loading at elevated temperatures. Author

N64-21254* Battelle Memorial Inst., Columbus, Ohio
DEVELOPMENT OF ALUMINUM CASTINGS WITH HIGH IMPACT STRENGTH AT LOW TEMPERATURES
D. N. Williams, R. A. Wood, and H. R. Ogden Washington, NASA, Jun. 1964 83 p refs
(Contract NAS8-1689)
(NASA-CR-58) OTS: $2.25

This program was initiated to determine whether high-strength aluminum castings could be developed that would show impact properties at low temperatures significantly better than those of present-day aluminum castings. Present space-vehicle technology has resulted in considerable interest in complex aluminum-alloy components for use at very low temperatures. Because of the relatively small number of components of a specific configuration required, the use of sand castings is economically quite advantageous. Author

N64-21286 Joint Publications Research Service, Washington, D.C.
THERMOMECHANICAL TREATMENT AND STRENGTHENING OF ALLOYS
A. P. Gulyaev, A. S. Shigarev et al 4 Jun. 1964 31 p refs
Transl. into ENGLISH of 3 articles from the book "Issledovaniya po Vysokoprochnym Splavam i Nitevidnym Kristallam" Moscow, USSR Acad. of Sci., 1963 p 75–89, 142–147
(JPRS-24942; OTS-64-31413) OTS: $0.75

CONTENTS:
1. THERMOMECHANICAL TREATMENT OF STEEL AND ITS EFFECT ON FINE STRUCTURE AND MECHANICAL PROPERTIES p 1–7
2. STRENGTHENING OF AUSTENITIC ALLOYS BY METHODS OF PHASE HARDENING p 8–20 refs
3. THERMOMECHANICAL TREATMENT OF TITANIC ALLOYS p 21–30

N64-21298 Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
EFFECT OF DEGREE OF VACUUM ON THE SLOW-BEND CREEP BEHAVIOR OF COLUMBIUM-0.6% ZIRCONIUM AT 1000°C
T. K. Roche Jun. 1964 24 p refs
(Contract W-7405-ENG-26)
(ORNL-3569)

Columbium and its alloys are subject to interstitial contamination in vacuum environments, and the interstitials, in turn, influence the mechanical properties of these materials. To investigate creep behavior during contamination, the deflection rates of cantilevered Cb–0.6% Zr specimens, loaded to an initial outer fiber stress of 12,500 psi, were determined at pressures ranging from approximately 10^{-7} to 10^{-5} torr for a test period of 504 hr at 1,000° C. A typical deflection-time curve exhibited an approximately linear steady-state deflection rate during the early stages of test followed by a continuously decreasing rate for the duration of the test. It was observed that systematic increases of the test pressure progressively weakened the alloy during the steady-state stages and strengthened the alloy during the later test stages. At a test pressure in the range of 1.6 to 6 × 10^{-5} torr, the alloy was significantly weakened at a still later stage of testing. To further demonstrate the effect of the test pressure, it was possible to accelerate or decelerate the deflection rate of a single specimen by increasing or decreasing the test pressure.
Author

N64-21307 Carnegie Inst. of Tech., Pittsburgh, Pa.
DIFFUSION IN B.C.C. METALS
R. A. Wolfe and H. W. Paxton 1 Mar. 1964 26 p refs
(Contract Nonr-760(08))
(AD-432969)

The investigation of diffusion in body-centered cubic metals was undertaken in an attempt to understand the contributing factors in the anomalous behavior of various elements. In the method used, a thin layer of radioisotope material of the diffusing element is plated or coated onto a planar surface of the diffusion sample, which is then given an isothermal diffusion annealing treatment. Two radioactive tracers, Cr^{51} and Fe^{55}, were used. Diffusion coefficients were determined for the diffusion of one or both of these tracers in four different materials, viz., Fe–12% Cr alloy, Fe–17% Cr alloy, chromium, and vanadium. The results indicate that a wide and complex variation occurs with composition, and that vacancy diffusion is probably operative. D.S.G.

N64-21347 National Bureau of Standards, Washington, D.C. Electrolysis and Metal Deposition Section
DEPOSITION OF TUNGSTEN BY REDUCTION OF THE HEXAFLUORIDE WITH HYDROGEN IN THE VAPOR PHASE Quarterly Report, 1 Feb.-30 Apr. 1964
Jean H. Connor and Abner Brenner 14 May 1964 10 p
(Contract AF 33(615)-6405)

The development of equipment and devices for testing the properties of tungsten deposited by the vapor-phase method is described. A study of the effect of oxygen and hydrogen fluoride on the deposition of tungsten was initiated. Some measurements were made of the density and electrical resistivity of the tungsten. R.T.K.

N64-21354 Massachusetts Inst. of Tech., Cambridge Metals Processing Div.
INVESTIGATION OF SOLIDIFICATION OF HIGH STRENGTH STEEL CASTINGS Interim Summary Report, 9 Dec. 1961-8 Dec. 1962
Dec. 1962 51 p refs
(Contract DA-19-020-ORD-5443(X))
(AMRA-CR-63-04/1; AD-432999)

A furnace with related apparatus for fully controlling solidification in small samples of iron-base alloys was completed and installed. Studies were conducted using the equipment to study solidification of an iron–nickel alloy. Emphasis of the work was on effect of cooling rate on details of dendrite morphology and on microsegregation in a solute-rich system. At higher cooling rates, there is a tendency for formation of primary plates (filling in of interstices between primary and secondary arms during the early stages of solidification). At lower cooling rates, there is a tendency for formation of secondary plates (filling in of interstices between secondary and tertiary dendrite arms). Dendrite arm spacing increases linearly with the reciprocal of the square root of the cooling rate. Secondary and tertiary arm spacings are roughly equivalent. Index of segregation was found to decrease with decreasing cooling rate for samples cooled at relatively slow rates and quenched at 100° F below the liquidus (for cooling rates from 14.70° F per minute to .13° F per minute). Index of segregation increased as the temperature of quenching was increased. Results indicate substantial diffusion of nickel in the solid during and after solidification. Author

N64-21382 Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. Electromechanical Div.
DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS II Bimonthly Report No. 5, 1 Nov. 1963-1 Jan. 1964
D. B. Warmuth 1 Feb. 1964 58 p refs
(Contract NOw-63-0471-c)
(TM-3866-67; RRMA-232; AD-432319)

The major part of the design data study mechanical-property tests on Pfaudler- and TRW-coated 30-mil B-66 and D-43 columbium alloy sheet have been completed. The results of tensile tests conducted on coated sheet in the temperature range room temperature to 2,600° F are reported and compared with properties of uncoated sheet. A limited study of the effect of different tensile strain rates in the 2,300° to 2,600° F temperature range is discussed. Results of creep tests conducted on the coated B-66 and D-43 alloy sheet are reported. These data pertain to tests run at 1,600°, 2,000°, 2,300°, and 2,600° F in air. Preliminary results of coating deformation tolerance tests at room temperature, 400°, and 800° F are presented. Author

N64-21392 National Technical U., Athens (Greece)
CREEP CHARACTERISTICS OF TENSION MEMBERS IN HIGH TEMPERATURES BY USING THE PHOTO-SCREEN METHOD Report Covering Period, Nov. 1, 1962-Oct. 31, 1963
Pericles S. Theocaris [1963] 4 p refs
(Contract DA-91-591-EUC-2727)
(FTR-3/5-12-1963; AD-432681)

The photoscreen method was used for the analysis of strains and stresses in externally loaded bodies at elevated temperatures. The model was used for the measurement of relative displacements along the two principal directions of the specimens, from which the longitudinal and transverse components of strains were derived. The influence of temperature on the instability phenomenon due to the nucleation and propagation of Luder's bands was studied. Conventional and true longitudinal and transverse stress–strain curves of these materials were traced at various increments of temperature from the ambient up to 450° C (850° F), and the resulting lateral contraction ratio true stress or strain curves were plotted. N.E.A.

N64-21405 Thiokol Chemical Corp., Huntsville, Ala. Alpha Div.
ARMY MATERIALS RESEARCH AGENCY, CASE EVALUATION Interim Technical Report, 22 Jun.-21 Dec. 1963
R. M. Sforzini, C. B. Steger, D. L. Daigle, R. E. Black, and G. D. Case 23 Mar. 1964 10 p
(Contract DA-01-121-ORD-11919)
(Rept.-14-64; AD-433217)

One second-stage Pershing-rocket motor case made of hot-cup cold-drawn D6A steel was submitted for evaluation, but is being held pending receipt of test requirements from the Army. Also, a general test plan recommended for evaluating from one to six experimental metal cases of one design is presented. This plan is aimed at subjecting the available cases to tests yielding the most useful data for rocket-motor applications. However, a specific test plan will be written for each lot of cases to be tested. I.v.L.

N64-21410 Southern Research Inst., Birmingham, Ala.
MECHANICAL AND PHYSICAL PROPERTIES OF TZM MOLYBDENUM ALLOY SHEET AND OF TUNGSTEN SHEET Sixth Quarterly Progress Report, Feb. 1-Apr. 30, 1964
Clifford L. Dotson 15 May 1964 83 p refs
(Contract N600(19)59530)
(Rept.-6774-1479-6; AD-600281)

The preparation of the tungsten and TZM specimens for most of the different evaluations has been completed. Tensile tests on the tungsten sheet have continued. The recrystallization characteristics of the three TZM materials (of three different sheet gages) and the bend-transition temperature of the TZM sheet in the optimum condition have been determined. Several specimens have been shipped for trial application of the two coatings (PFR-6 and W-3). Specimens of both TZM and tungsten, for all of the remaining evaluation in the recrystallized condition, have been shipped for recrystallization at predetermined time–temperature conditions. The different evaluations for 0.060-in.- and 0.10-in.-thick tungsten sheets and 0.020-in.-, 0.040-in.-, and 0.060-in.-thick TZM sheets are presented. Also presented are processing and property certifications for TZM sheet supplied for the investigation of property variations within sheets and between sheets, heats, and gages. I.v.L.

N64-21442 General Electric Co., Schenectady, N.Y. Research Lab.
PEST REACTIONS IN INTERMETALLIC COMPOUNDS. II. INVESTIGATIONS ON NiAl, AND TWO $MoSi_2$ STRUCTURES Technical Documentary Report, Feb. 1963-Feb. 1964
A. U. Seybolt and J. H. Westbrook Wright-Patterson AFB, Ohio, ASD, Apr. 1964 46 p refs
(Contract AF 33(657)-7980)
(ASD-TDR-63-309, Pt. 2; AD-439216)

The grain boundary hardening phenomena investigated earlier in the case of the intermetallic compound NiGa occurred in much the same manner in NiAl. As before, an oxygen-contamination heat treatment followed by a sufficiently high temperature quench shows no hardening, but subsequent lower temperature aging sets up hardening. Hardening occurs in the bulk as well as along gain boundaries, but generally the effect is harder to observe in the former case because of shallow oxygen penetration in the bulk as compared to the grain

boundaries. A vacancy-oxygen atom interaction model is suggested as a likely explanation for the observed hardening. Some observations were made on pest failure in $MoSi_2$, and grain boundary hardening in the structural analog $CrAl_2$. It is difficult to find suitable experimental techniques to study the pest failure of $MoSi_2$. As-cast material is more susceptible to pest failure than $MoSi_2$ coatings on molybdenum sheet. Author

N64-21462 Battelle Memorial Inst., Columbus, Ohio
FURTHER DEVELOPMENT OF A DUCTILE TUNGSTEN-BASE SHEET ALLOY Summary Report, Feb. 3, 1963-Apr. 3, 1964
J. L. Ratliff, D. J. Maykuth, H. R. Ogden, and R. I. Jaffee
30 Apr. 1964 79 p refs
(Contract N600(19)-59738)
(AD-600764)

An experimental program was conducted with the primary objective of developing a room-temperature ductile tungsten-base alloy. The alloying approach employed was to study the combined effects of small additions of rhenium or iridium to tungsten for matrix softening and fine inert oxide dispersions of ThO_2 or ZrO_2. Also, for these alloy compositions, the effects of alkali-silicate doping additions to the matrix were studied as to their ability to control grain size and recrystallization behavior. Optimum property combinations were found for W-5Re-ThO_2 type alloys prepared using a commercially doped tungsten powder. The culmination of this research was the development of a W-5Re-4ThO_2 alloy that showed an ultimate strength of 193 ksi, a yield strength of 182 ksi, and a 6% elongation in tension at room temperature. This alloy also showed a 1-hr recrystallization temperature of 2,000° C and an ultimate tensile strength of 36.6 ksi at 1,650° C (3,000° F). Author

N64-21476* Atomics International, Canoga Park, Calif.
SOLUBILITY AND DIFFUSION STUDIES OF ULTRA PURE TRANSITION ELEMENTS IN ULTRA PURE ALKALI METALS Third Quarterly Report, Dec. 29, 1963-Mar. 28, 1964
R. L. Mc Kisson, R. L. Eichelberger, G. R. Argue, and J. M. Scarborough 11 May 1964 31 p refs
(Contract NAS3-4163)
(NASA CR-54043; AI-64-75) OTS: $3.60 ph

Progress is reported on a study designed: (1) to define the solution process and determine the equilibrium solubility of highly purified liquid alkali metals, and (2) to measure the diffusion of transitional metals and constituents of selected compounds in highly purified liquid alkali metals. The studies made include the measurement of solubility in the alkali metal at temperatures up to 1,200° C, coupled with the investigation of the rate-controlling step and its energy of activation and the measurement of the liquid state diffusion rate and its energy of activation, also to 1,200° C. It is the goal of this study to develop solubility and diffusion data for well-characterized experimental systems, in which the number and range of complicating variables are minimized. N.E.A.

19 MATERIALS, NONMETALLIC

Includes mechanical and physical properties of nonmetals (e.g., plastics). *For related information see*: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N64-20794* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
NONMETALLIC SOLIDS. A: CERAMICS (THERMODYNAMICS)
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 75-78 (See N64-20783 14-01) OTS: $5.00

A few materials are discussed with reference to their resistance to attack by liquid metals. The most important examined were the oxidic ceramics often used as insulators—thermal or electrical. Impurity levels in ceramics tend to be much higher than those in metals. The most extensive work with insulating ceramics had been done with alumina. Silica has been found generally harmful in crystalline ceramics. Glass has poor corrosion resistance with sodium and the other alkali metals. Generally speaking, alkali vapors are less destructive on glasses than the liquids because the atoms per cubic centimeter are less in the vapor state. A.W.

N64-20795* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
NONMETALLIC SOLIDS. B: GRAPHITE
Leo. F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 79-81 ref (See N64-20783 14-01) OTS: $5.00

This is a discussion of the behavior of graphite in liquid sodium and other metallic fluids. Graphite has a tendency to exhibit instability in exposure to sodium. Lithium forms a carbide quite readily; and potassium, rubidium, and cesium form well-characterized compounds with graphite. The resistance of graphite to sodium will depend largely on the elimination of defects and fissures in the lattice; this can be influenced by the method of preparation of the graphite. However, graphite remains a material whose corrosion resistance in sodium is poor and, in using it in a liquid metal system, jacketing is almost mandatory. A.W.

N64-20807* Argonne National Lab., Ill.
PURIFICATION OF ARGON FOR GLOVE BOXES AND ENVIRONMENTAL CHAMBERS
M. F. Parkman *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 313-316 refs (See N64-20783 14-01) OTS: $5.00

Argon is used as a cover gas for alkali metals or hot refractory metals in several applications. The major problems are twofold—establishing and achieving maximum desired contaminant levels. This paper discusses an attempt to solve the second problem by using gas with the lowest-obtainable impurity level. Measurements were made of two types of gas purifiers—a CEC moisture monitor and an oxygen analyzer. A.W.

N64-20815* National Beryllia Corp., Haskell, N.J.
STUDY OF IMPROVED BERYLLIUM OXIDE MATERIALS FOR MICRO-ELECTRONICS TECHNOLOGY Bi-Monthly Report, 1 Jul.-31 Aug. 1963
P. S. Hessinger 15 Sep. 1963 16 p
(Contract NASw-685)
(NASA CR-56190) OTS: $1.60 ph

Study of the growth of single crystals of beryllium oxide was pursued in two ways: growth of BeO crystals by the water-vapor transport technique, which utilizes the generation of $Be(OH)_2$ vapor from a BeO nutrient with a subsequent condensation on a seed surface at elevated temperatures; and an exploratory study of the flux growth method utilizing alkali molybdate solvents. Studies were also conducted to determine the precise dielectric, optical, and thermal properties of beryllium oxide single crystals. R.T.K.

N64-20830 Joint Publications Research Service, Washington, D.C.
FLUXES FOR ELECTROSLAG WELDING
V. V. Podgayetskiy 26 May 1964 34 p refs Transl. into ENGLISH from Avtomat. Svarka (Kiev), no. 4, Apr. 1956 p 30–49 (JPRS-24769; OTS-64-31336) OTS: $1.00

The methodology was developed, and the electrical conductivity was measured of a number of fluxes in the interval of temperatures from 900° through 1,450° C. The viscosity of these fluxes was measured. A comparison was made of the viscosity and electrical conductivity of the fluxes with their technological properties during electroslag welding. Author

N64-20872 Institut Francais du Petrole, Paris (France)
PETROLEUM-BASED ORGANIC COOLANTS FOR NUCLEAR REACTORS [CALOPORTEURS ORGANIQUES D'ORIGINE PETROLIERE POUR REACTEURS NUCLEAIRES]
G. P. de Gaudemaris, E. de Gorski, P. Giuliani, and G. Leleu Brussels, EURATOM, Mar. 1964 18 p refs In FRENCH; ENGLISH summary Presented at the 6th World Petrol. Cong., Frankfurt am Main, 19–26 Jun. 1963
(Contract EURATOM 062-62-4 ORGF)
(EUR-496.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

Hitherto the use of polyphenyls has been advocated, but although they are fairly satisfactory, their excessively high solidification point constitutes a certain technological drawback. Their high cost restricts their use, for consumption runs to several grams per kwh of electrical energy produced, owing in particular to radiolysis. Studies were conducted on the various aromatic petroleum cuts that the oil industry can supply cheaply. On the basis of their thermal and radiolytic stability, the alkyl phenanthrene cuts extracted from the power-forming residue were chosen as the most suitable. By virtue of their origin, these cuts have the advantage of being completely free from impurities and are entirely aromatic. Their radiolytic stability is excellent, being better than that of the terphenyls. Their thermal stability, which is less satisfactory, can be improved by additional refining. This paper outlines the preparation, purification, characteristics, and detailed composition of these cuts, together with their behavior during high-temperature irradiation tests in a loop. Author

N64-21006 European Atomic Energy Community, Brussels (Belgium) General Directorate Res. and Training
ELECTRON MICROSCOPE STUDY OF INTERLAMELLAR COMPOUNDS OF GRAPHITE WITH BROMINE, IODINE MONOCHLORIDE AND FERRIC CHLORIDE
S. Amelynckx (CEN), P. Delavignette (CEN), and M. Heerschap Mar. 1964 36 p refs Presented at the 6th Bien. Conf. on Carbon, Pittsburgh, 17–21 Jun. 1963
(EUR-542.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 60 Belg. Fr.

Evidence is given of the existence of isolated dislocations in graphite–bromide and graphite–iodine monochloride, which bound the intercalated reactant layers. These boundary dislocations show stacking fault contrast to one side. The basal component of the Burgers vector lies along one of the three projections of the $\{11\bar{2}0\}$ planes on the basal plane, compatible with the Burgers vectors of normal partial dislocations. It is thought that the carbon hexagon networks on either side of a reactant layer are shifted in identical positions. Evidence is further given of a mechanism by which moving boundary dislocations leave numerous loops of occluded reactant behind on their way through the crystal. Investigated and discussed are interactions of a boundary dislocation and a normal dislocation ribbon, as well as the widening of dislocation ribbons presumably by preferential diffusion of reactant along the ribbon. The situation in the graphite–ferric chloride compound proved to be more complicated, and the results not consistent. Author

N64-21019 Picker X-Ray Corp., Cleveland, Ohio Waite Mfg. Div., Inc.
RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE Technical Documentary Report, Feb. 1, 1962–Jan. 31, 1963
Thomas C. Furnas, Jr. and M. R. Rosumny Wright-Patterson AFB, Ohio, AF Materials Lab., Apr. 1964 32 p refs Prepared for Natl. Carbon Co.
(Contract AF 33(616)-6915)
(WADD-TR-61-72, vol. 17; AD-600339)

A study has been made to establish optimum exposure conditions for the radiographic detection of minimum-size defects in thicknesses of graphite varying from 4 to 16 inches. Through the use of grids and associated techniques, 0.5-percent sensitivity or better was attained on high-density graphite as follows: 4-in. graphite—0.5-percent sensitivity on M, single emulsion M and HD films at 110 kv; 8-in. graphite—0.4-percent sensitivity on AA film at 150 kv; 12-in. graphite—0.35-percent sensitivity on HF film with Cobalt-60; and 16-in. graphite—0.3-percent sensitivity on HD film with Cobalt-60. Other parameters and techniques were investigated, such as direct X-ray magnification, screens, films, developers, and position of defect. The use of the grid made the greatest contribution toward an increase in sensitivity. Author

N64-21025 Army Materiel Command, Hanover, N.H. Cold Regions Research and Engineering Lab.
DYNAMIC RESPONSE OF SNOW TO HIGH RATES OF LOADING Final Report, Jul. 1961–Jun. 1962
H. S. Napadensky Mar. 1964 45 p refs
(Contract DA-11-190-ENG-127)
(CRREL-119; AD-60075)

An experimental investigation of stress-wave propagation in snow and ice is described. Seven types of Greenland snow were investigated to determine the extent to which the variation in dynamic response of the snow is a function of snow types, and were compared with results of similar Michigan snow experiments. A low-density explosive charge was detonated, sending a steep-fronted shock wave through a metal transfer plate and into the snow sample, compressing the snow and setting it in motion. Measurements were made on shock waves with amplitudes of less than 200 atm. Density and pressure behind the wave fronts were determined by simultaneous measurement of wave-propagation and particle velocity as limited by the fast elastic wave and the slower plastic wave of the two-front structure. Values calculated by the Rankine-Hugoniot jump conditions determined the points at which the material behaves plastically or hydrodynamically. The maximum stable pressure-volume states that snow can reach under shock loading are also shown. Sources of scatter in the results from variations in snow type and errors in data reduction and geometry changes are pointed out. Author

N64-21026 Aerospace Corp., El Segundo, Calif. Aerodynamics and Pulsion Research Lab.
UNCLASSIFIED ANNOTATED BIBLIOGRAPHY RELATING TO THE SYNTHESIS AND PHYSICAL PROPERTIES OF ALUMINUM HYDRIDE AND CLOSELY RELATED COMPOUNDS [1937–1963]
Peter Breisacher 21 Feb. 1964 18 p refs
(Contract AF 04(695)-269)
(TDR-269(4210-10)-4; SSD-TDR-64-17; AD-439243)

The open literature for the period 1937 through 1963 has been searched for all references on the subject of aluminum hydride. Many of the references have proved to be somewhat

erroneous in their conclusions in the light of present day knowledge on the subject. However, for completeness, all are included. The references are listed chronologically by year.

Author

N64-21027 Beryllium Corp., Reading, Pa.
PRODUCTION ENGINEERING MEASURE FOR BERYLLIUM OXIDE AND PARTS PRODUCED FROM IMPORTED ORES Second Quarterly Progress Report, Oct. 1-Dec. 31, 1963
J. F. Blum and W. R. Raymont [1963] 38 p
(Contract DA-36-039-AMC-01481(E))
(AD-600126)

Physical property measurements have been completed on beryllium oxide test pieces that were produced from standard powder and fabrication processes. The fabricated shapes were 99-percent pure and were a minimum of 96 percent of theoretical density. Average test values are as follows: dielectric constant and loss factor, 6.43 and 0.00089, respectively, at 23° C; dielectric strength, 209 v/mil at room temperature; flexural strength, 26,000 psi at room temperature; and thermal conductivity, 1516 Btu x in./hr. x ft^2 x °F at 100° F, and 1056 Btu x in./hr. x ft^2 x °F at 280° F. Four typical beryllium oxide parts for use in the electronics industry have also been produced to required specifications employing standard fabrication processes.

Author

N64-21067 Oklahoma U. Research Inst., Norman
AGING OF CURED DATED ITEMS AND VARIOUS ELASTOMERIC COMPOUNDS Final Report
Andrew Cosgarea, Jr., Robert K. Mortenson, and Robert W. Vaughn 30 Sep. 1963 83 p refs
(Contract AF 34(601)-14089)
(AD-432369)

A summary and evaluation of the following are given: (1) accelerated air-aging studies on Stillman Rubber Co. Compound 822-60; (2) accelerated air-aging studies on Precision Rubber Co. Compound 7866; (3) accelerated aging studies on Stillman Rubber Co. Compound 822-60 when totally immersed in storage oil; (4) temperature retraction tests as an indication of aging; (5) vaporization of volatile components in SR-822-60 rubber samples; (6) infrared studies on constituents leached from SR-822-60 rubber samples; (7) vapor-phase swelling tests on SR-822-60 rubber samples; and (8) accelerated aging experiments with Paracil-D and Hycar-1001 rubber stocks.

R.T.K.

N64-21163 Princeton U., N.J. Frick Chemical Lab.
SULFUR AS A PLASTICIZER FOR DISULFIDE POLYMERS
M. Takahashi, W. J. Mac Knight, and A. V. Tobolsky May 1964 18 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-78; AD-440179)

It is shown that large amounts of elemental sulfur, (S_β), in a supercooled liquid condition, can exist mixed with both crosslinked and uncrosslinked disulfide polymers. In this state the sulfur is an excellent plasticizer for the disulfide polymers. The viscoelastic behavior of the mixtures is discussed in terms of their modulus-temperature curves, their characteristic viscoelastic parameters, their chemical relaxation times, and their shear flow viscosities. Many of the mixtures are stable at room temperature for long periods of time.

Author

N64-21203 National Bureau of Standards, Washington, D.C.
COMPILATION OF THE MELTING POINTS OF THE METAL OXIDES
Samuel J. Schneider 10 Oct. 1963 35 p refs
(NBS-MONOGRAPH-68) GPO: $0.25

A compilation has been made of the melting points of 70 metal oxides published prior to January 1963. Both the original melting point and the equivalent value based on the International Practical Temperature Scale of 1948 are presented. Included in the survey is information on pertinent experimental details, such as the method of temperature measurement, purity, furnace type, and environmental conditions.

Author

N64-21322 Southern Research Inst., Birmingham, Ala.
THE DETERMINATION OF DESIGN CRITERIA FOR GRADE CFZ GRAPHITE Third Progress Report, 1 Jan.-31 Mar. 1964
F. J. Digesu 30 Apr. 1964 33 p
(Contract AF 33(657)-11298)
(AD-438206)

A standard micrometer and a standard analytical balance were utilized for bulk-density determinations. The micrometer was employed to measure each dimension of the CFZ graphite specimens to the nearest 0.001 inch. The maximum percentage error and the standard deviation and probable error involved in the determination of bulk density with these instruments were determined. The values of bulk density for all specimens are given in tabular form, along with the average densities and the standard deviations of individual areas of the original billet. Radiographic examination of some of the specimens was completed. The modification of the furnace that is to be used to determine electrical resistivity was completed. A temperature of 5,700° F was attained and held for several minutes before the electrical insulation broke down. Modifications of the flexural apparatus were completed to accommodate a 1/2-in. × 1/2-in. × 5-in. specimen size, and some preliminary calibration runs were made.

R.T.K.

N64-21395 Aerojet-General Corp., Downey, Calif.
EXPERIMENTAL FRACTURE STUDIES AND EQUATION-OF-STATE MEASUREMENTS Final Report, Jun. 1962-Oct. 1963
N. A. Louie, W. H. Anderson, and M. H. Wagner Kirtland AFB, N. Mex., Res. and Technol. Div., Mar. 1964 61 p refs
(Contract AF 29(601)-5382)
(RTD-TDR-63-3102; AD-433240)

Studies of crack-propagation rates in plastics and polycrystalline aluminum were conducted to help test the validity of Waldorf's fracture theory. Results of these studies revealed that the omission of plastic-flow effects in the Waldorf equation is a serious neglect, since this flow can appreciably alter the effective stress at the crack tips under suitable conditions. This phenomenon will modify the temperature dependence of the strength of the material from that given by the theory and its a priori determined parameters. A discussion of fracture-time delay is also included. Dynamic-compression data were experimentally determined for four reentry vehicle materials: Avcoat II, chopped nylon phenolic, RAD 60, and Series 124A resin. These data have been used to formulate a Hugoniot equation of state for each material.

Author

N64-21406 Bureau of Mines, Pittsburgh, Pa. Coal Research Center
ABSORPTION CORRECTIONS FOR INTENSITY OF X-RAYS SCATTERED BY WEAKLY ABSORBING POLYTYPE-CRYSTALLINE MATERIALS
Victor H. Tiensuu, Robert W. Smith, Jr., and Sabri Ergun Washington, Dept. of Interior, 1964 16 p
(BM-RI-6455)

Factual geometries are considered for X-ray scattering studies of weakly absorbing materials by both reflection and transmission methods. These studies are usually made on slab specimens to obtain adequate scattered intensities; however, the intensities are appreciably influenced by absorption of the X-rays in passing through the specimens. Conventional equations derived to account for this absorption are based on idealized geometries, but for polycrystalline carbons the use of idealized geometries leads to several percent error in the corrections to be made. Use of factual geometries substantially reduces this error. Author

N64-21452 Air Force Systems Command, Edwards AFB, Calif. Rocket Propulsion Lab.
A COMPATIBILITY EVALUATION OF PLASTIC MEMBRANE FILTERS WITH LIQUID PROPELLANTS AND SOLVENTS
Robert A. Biggers Feb. 1964 27 p refs
(RPL-TDR-64-38; AD-434592)

Data are presented to show the compatibility of polyethylene filter membranes with 11 propellants and 8 solvents. More than 300 tests were conducted at ambient temperatures for periods up to 52 hours. The filters tested are satisfactory for use in the gravimetric determination of particulate matter in most liquid propellants. Author

N64-21455 Atomics International, Canoga Park, Calif.
THERMAL PROPERTIES OF REFRACTORY MATERIALS
R. E. Taylor and M. M. Nakata Wright-Patterson AFB, Ohio, AF Mat. Lab., Apr. 1964 118 p refs
(Contract AF 33(657)-7136)
(WADD-TR-60-581, Pt. 4 ; AD-428669)

A new technique for the measurement of the thermal diffusivity at high temperatures is described. The diffusivity is determined from the time interval separating two radial isotherms in a cylindrical specimen. The observations are made during the transient heating (or cooling) period, using a sensitive photoelectric pyrometer developed for the purpose. Measurements are reported on Armco iron, Ta, W, TiC, Zrc, HfC, and TaC. Data were obtained on TiC, TiN, and ZrC, in order to check previous results and to provide internal standards for testing the new thermal diffusivity technique. Data that disprove previous literature results are reported on these compounds. The significance of the work, from the standpoint of contemporary theory, is discussed. Work on the thermal expansion and specific heat of various refractory materials is also described. Author

N64-21456 Brussels U. (Belgium)
VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURES. PART XXII: MASS SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF THE MOLECULES MgO, CaO, SrO AND Sr_2O
John Drowart, G. Exsteen, and G. Verhaegen Wright-Patterson AFB, Ohio, AF Mat. Lab., Apr. 1964 36 p refs
(Contract AF 61(052)-225)
(WADD-TR-60-782, Pt. 22 ; AD-600442)

The dissociation energy of the molecules MgO, CaO, and SrO was determined—$D^\circ_o(MgO) = 85 \pm 5$; $D^\circ_o(CaO) = 92 \pm 5$; $D^\circ_o(SrO) = 102 \pm 5$ kcal/mole. The ground state was considered to be $^1\Sigma$. This choice is discussed. A review and discussion of the literature values for D°_o (MgO, CaO, SrO) are made. The molecule Sr_2O was identified, and its atomization energy was determined: $\Delta H^\circ_{o,\ at}(Sr_2O) = 193 \pm 6$ kcal/mole. Author

20 MATHEMATICS

Includes calculation methods and theory; computers; data processing; and numerical analysis. *For related information see*: 08 Communications; 09 Electronics; 10 Facilities, Research and Support; and 22 Navigation and Guidance.

N64-20833 European Atomic Energy Community, Brussels (Belgium)
FINITE DIFFERENCE METHOD FOR SOLVING THE SPATIO-TEMPORAL DIFFUSION EQUATION IN THE TWO-GROUP APPROXIMATION. COMPARISON BETWEEN THE SOLUTION BY AN ITERATIVE AND A DIRECT METHOD
R. Monterosso and E. Vincenti Joint Nucl. Res. Center, Ispra Estab. (Italy), Feb. 1964 36 p refs
(EUR-596.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account no. 121.86: 50 Belg. Fr.

The two spatio-temporal diffusion equations of the two-group approximation are transformed into a system of linear equations, by means of the finite difference method. This system can be divided into two systems, fast and thermal. They are solved separately, and each solution is used as source for the other system. The process is iterated until it converges. With a convenient disposition of the equations in the system, the matrix of the coefficients can be transformed into a tridiagonal matrix of 2 × 2 submatrices. The whole system can be solved directly. A comparison between the two methods is made with numerical examples. Author

N64-20842 State U. of New York, Stony Brook Coll. of Engineering
THE TIME DOMAIN SYNTHESIS OF DISTRIBUTIONS
Third Scientific Report
A. H. Zemanian Feb. 1964 56 p refs
(Contract AF 19(628)-2981)
(AFCRL-64-191; Rept.-19; AD-600236)

A new dimension to the time-domain synthesis problem is proposed. In particular, the objective is to find a realizable signal that approximates a given distribution (i.e., generalized function). A solution is then presented, several convergence criteria are discussed, and some examples are given. A feature of the present technique is that, if the Laplace transform of the given distribution is known, the realizable approximating signal can be written down without any computation. It only requires values of the Laplace transform at various points in its region of convergence. The method also yields a convenient technique for "visualizing" those distributions that cannot be plotted. Since ordinary locally integrable functions are special cases of distributions, the technique is significant for the customary time-domain synthesis problem as well. Author

N64-20862 General Electric Co., Santa Barbara, Calif.
INVESTIGATION OF DYNAMIC PROGRAMMING METHODS FOR FLIGHT CONTROL PROBLEMS
E. L. Peterson and F. X. Remond, Sr. Wright-Patterson AFB, Ohio, Flight Dynamics Lab., Mar. 1964 79 p refs
(Contract AF 33(657)-10100)
(FDL-TDR-64-11; AD-600230)

A discussion of dynamic programing and some of the closed form solutions that were derived along with a sample solution to a simple problem were used to introduce the method. The problem of finding optimal control for a thrusting vehicle is investigated using three approaches. First, the criterion of minimum squared terminal error with respect to a

predetermined impact point is studied using polynomial approximation with Tchebicheff polynomials to represent the return, which is a function of three variables. Next, the minimum time intercept using a discrete return function representation is investigated. The return in this case is a function of two variables. Finally, a one-dimensional stochastic problem is studied. The criterion chosen is the probability that the interceptor comes within a prescribed distance of the desired impact point. Results indicate that polynomial approximation is not useful unless the return function is representable exactly as a polynomial of a given order. Buildup errors tend to rapidly destroy the validity of the return function. This is amply demonstrated by the negative values that appear in the return function after a few stages, for a problem in which the criterion is positive definite. Author

N64-20870 European Atomic Energy Community, Brussels (Belgium)
CODE FOR THE SOLUTION OF SYSTEMS OF BOOLEAN EQUATIONS [CODE POUR LA SOLUTION DE SYSTEMES D'EQUATIONS BOOLEENNES]
A. Debroux Joint Nucl. Res. Center, Ispra Estab. (Italy) Sci. Inform. Process. Center, Dec. 1963 13 p in FRENCH, ENGLISH summary
(EUR-211-f; CETIS-53) Available from Belgian Am. Bank and Trust Co., Account No. 121.86: 40 Belg. Fr.

This report describes the theoretical foundations of a code for the solution of systems of Boolean equations and gives an example of its application. The process used involves the manipulation of Boolean polynomials of high order, and the simplification of these polynomials necessitates a large number of comparisons of Boolean monomes. The report contains two theorems that enable a substantial reduction in this number of comparisons, since in the usual method, their number grows in proportion to the square of the number of terms; here the increase is nearly linear. This permits the treatment of systems that were hitherto considered as too complex for a practical solution. Author

N64-20871 European Atomic Energy Community, Brussels (Belgium)
THE APPLICATION OF THE DIRECT METHOD OF THE VARIATIONAL CALCULUS [UBER LOSUNGSVERFAHREN FUR DIE BOLTZMANN-GLEICHUNG]
K.-H. Müller Joint Nucl. Res. Center, Ispra Estab. (Italy) Reactor Phys. Dept., Feb. 1964 13 p refs In GERMAN, ENGLISH summary
(EUR-217.d, Pt. 1) Available from Belgian Am. Bank and Trust Co., N.Y., Account no. 121.86: 40 Belg. Fr.

A functional is given in which the P_1 approximation to the Boltzmann equation of neutron dynamics is in the form of Euler equations. The requirement for the related extreme values is thus equivalent to the differential equation system of the P_1 approximation. The direct method of calculating variations can be used to solve the variation problem. An exclusive system of selection functions, suitable for concrete reactor problems, provided a clear and simple method of calculating criticality and neutron flux. With the direct method the spatial coordinates were also eliminated from the Boltzmann equation, so that a point model, i.e., an integral–differential equation was obtained, in which the only independent variables were the neutron speed and time. Author

N64-20939 Technische Hochschule Stuttgart (W. Germany) Inst. für Statik und Dynamik der Flugkonstruktionen
MATRIX METHODS OF STRUCTURAL ANALYSIS. A PRECIS OF RECENT DEVELOPMENTS [1956-1962]
J. H. Argyris (Imperial Coll., London), S. Kelsey, and H. Kamel *In* AGARD Matrix Methods of Structural Analysis 1964 p 1–164 refs (See N64-20938 14-33) Pergamon Press: £5

Certain parts of the current report were presented at the September 1959 meeting of the Structures Panel of AGARD in Aachen and included some of the advances in the matrix force and displacement methods, and their experimental verification effected in the period 1956–59. The most important (but, to a considerable extent, unpublished) contributions of the years 1956 to 1962 are given. The recent work from 1959 to 1962 originated, for the most part, at the Institut für Statik und Dynamik der Flugkonstruktionen of the Technical University in Stuttgart. Author

N64-20940 Liège U. (Belgium)
UPPER AND LOWER BOUNDS IN MATRIX STRUCTURAL ANALYSIS
B. M. Fraeijs de Veubeke (Louvain U.) *In* AGARD Matrix Methods of Structural Analysis 1964 p 165–209 (See N64-20938 14-33) Pergamon Press: £5

The following are included: (1) dual treatment of the triangular panel—uniform field, compatible net of triangular fields, and equilibrium net of triangular fields; (2) the stiffness method of resolution; (3) the quadrilateral panel subdivided by diagonals; (4) the force method of resolution; and (5) principles for the determination of upper and lower bounds to influence coefficients. R.T.K.

N64-20951* Grumman Aircraft Engineering Corp., Bethpage, N.Y.
SOLUTION OF VARIATIONAL PROBLEMS BY MEANS OF A GENERALIZED NEWTON-RAPHSON OPERATOR
Robert Mc Gill and Paul Kenneth *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 9–36 refs (See N64-20949 14-01)

This paper presents the development of an indirect method for solving variational problems by means of an algorithm that solves the associated nonlinear two-point boundary-value problem. The method departs from the usual indirect procedure of successively integrating the nonlinear equations and adjusting arbitrary initial conditions until the remaining boundary conditions are satisfied. Instead, an operator is introduced that produces a sequence of sets of functions that satisfy the boundary conditions but in general do not satisfy the nonlinear system formed by the state equations and the Euler–Lagrange equations. Under appropriate conditions this sequence converges uniformly and rapidly (quadratically) to the solution of the nonlinear boundary-value problem. The computational effectiveness of the algorithm is demonstrated by three numerical examples. Author

N64-20958* Kentucky U., Lexington
A MATRIX REPRESENTATION OF THE GENERAL CUBIC AND ITS TRANSLATION Special Report No. 7
T. J. Pignani, H. G. Robertson, J. B. Wells, Jr., and J. C. Eaves 18 Dec. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 173–182 refs (See N64-20949 14-01)
(Contract NAS8-1611)

The purpose of this report is to present a matrix method for representing the general cubic $\sum_{i,j,k} \alpha_{ijk} x_i x_j x_k$ and to give directly the coefficients of the cubic subjected to the transformation $x_i = y_i + \beta_i$, $i = 1, 2, \ldots, n$. This method enables one to compute the coefficients of the new cubic form in any order and to apply approximation in the final summing stages. Author

N64-20959* North Carolina U., Chapel Hill Computation Center
THE APPLICATION OF LINEAR PROGRAMMING TECHNIQUES TO RATIONAL APPROXIMATION PROBLEMS, II
Shigemichi Suzuki *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 183–208 refs (See N64-20949 14-01)

This paper formulates a number of linear programing algorithms for approximating, in the sense of Chebyshev, a function of many variables by a ratio of linear forms over a finite point set. Author

N64-20961* Northeast Louisiana State Coll., Monroe
THE SELECTION OF A LEAST SQUARES APPROXIMATING FUNCTION TO SATISFY A GIVEN ERROR TOLERANCE
Daniel E. Dupree, F. L. Harmon, R. A. Hickman, Edward B. Anders, and James O'Neil *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 223–231 refs (See N64-20949 14-01)

A technique is developed for obtaining a function that yields an error, in the sense of least squares, that is less than a specified tolerance. Author

N64-20962* Georgia Inst. of Tech., Atlanta Engineering Experiment Station
LEAST SQUARES ESTIMATION OF REGRESSION COEFFICIENTS IN A SPECIAL CLASS OF POLYNOMIAL MODELS
D. G. Herr, J. J. Goode, I. E. Perlin, and J. H. Mac Kay *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 233–265 refs (See N64-20949 14-01)

A method is proposed for the least squares fitting of a polynomial to data with applications to fitting solutions of the guidance equations. This method depends on restricting the class of polynomials (balanced polynomials) as well as on solving the guidance equations at certain sets of points. Author

N64-20964* Martin Co., Denver, Colo. Electronics Lab.
CONTROLLABILITY FOR LINEAR AND NONLINEAR SYSTEMS
H. Hermes Sep. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 281–303 refs (See N64-20949 14-01)
(Contract NAS8-11020)
(SR-0520-54)

The concept of complete controllability for linear systems was introduced by Kalman. A method of extending this concept to nonlinear systems with control appearing linearly is presented. R.T.K.

N64-20970 Lockheed Missile and Space Co., Sunnyvale, Calif.
DERIVATION OF DELBRUCK'S MODEL FOR RANDOM FAILURE (FOR SEMICONDUCTOR MATERIALS): ITS IDENTIFICATION WITH THE ARRHENIUS MODEL; AND ITS EXPERIMENTAL VERIFICATION
A. V. Pershing and G. E. Hollingsworth *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 61–67 refs (See N64-20967 14-09)

Space missions progressively require more complex equipment that will operate without failure for an extended period of time. The model described here provides an instrument for the prediction of part behavior for current requirements. Although a myriad of problems are introduced by manufacturing processes, the model indicates that semiconductors follow the same general trend in their failure characteristics. Manufacturing processes introducing solid, liquid, or gaseous environments appear to change only the slope and relative position of the failure trend. According to the model, the failure rate of semiconductors can change approximately from five to seven orders of magnitude, indicating extreme sensitivity of failure rate to temperature. Author

N64-20990 Hughes Aircraft Co., Newport Beach, Calif. Semiconductor Div.
APPLICATION OF FLOWGRAPH TECHNIQUES TO THE SOLUTION OF RELIABILITY PROBLEMS
W. W. Happ (Ariz. State U.) *In* RADC Phys. of Failure in Electron., Vol. 2 [1963] p 375–423 refs (See N64-20967 14-09)

Flowgraphs provide a new technique for establishing models that describe the functional relationship between the significant variables of a system. This paper discusses the motivation that stimulated the development of flowgraphs; the acceptance of the technique in engineering practice and academic work; and the epistemological criteria governing the logic of flowgraphs. A.W.

N64-21002 European Atomic Energy Community, Brussels (Belgium)
THE APPLICATION OF THE DIRECT METHOD OF THE VARIATIONAL-CALCULUS [UBER LOSUNGSVERFAHREN FUR DIE BOLTZMANN-GLEICHUNG]
K. H. Muller Joint Nucl. Res. Center Ispra Estab. (Italy) Reactor Phys. Dept., Feb. 1964 19 p refs in GERMAN; ENGLISH summary
(EUR-217.d, Pt. 2) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

Using the direct method of variational calculus, the 7-dimensional Boltzmann equation can be reduced to a space with a lower number of dimensions. The equations are reduced as follows: (1) A weighted integration over the reactor volume eliminates the space vector. (2) A weighted integration over the energy-spectrum eliminates the velocity vector. (3) A weighted integration over the reactor volume and the energy spectrum eliminates simultaneously the space vector as well as the velocity vector from the Boltzmann equation. The result of each of these three procedures is called the reduced Boltzmann equation. This matrix is an integro-differential equation in (1) velocity and time, (2) space and time, and (3) time. Author

N64-21018 Atomic Energy of Canada Ltd., Toronto, Ontario
DEEMS: A FORTRAN PROGRAM FOR SOLVING THE FIRST DEGREE COUPLED DIFFERENTIAL EQUATIONS BY EXPANSION IN MATRIX SERIES
L. Pease Feb. 1964 49 p refs
(AECL-1898) Available from Sci. Doc. Distribution Office, Chalk River, Ontario: $1.50

The DEEMS program obtains the solution of linear, first degree, coupled differential equations up to order 12. The method used is essentially different from finite difference methods; it does not depend upon being able to transform the coefficient matrix to diagonal form, nor does it require that the coefficient matrix be nonsingular. It is assumed that the coefficient matrix is real, though this is not essential to the method. Author

N64-21054* Minneapolis-Honeywell Regulator Co., Minn.
ROCKET BOOSTER CONTROL: PENALTY FUNCTIONS AND BOUNDED PHASE COORDINATE CONTROL
D. L. Russell Washington, NASA, May 1964 27 p refs
(Contract NASw-563)
(NASA CR-59) OTS: $0.75

The use of two different kinds of penalty functions to obtain approximate and, in the limit, exact solutions to the bounded-phase coordinate optimal-control problem is considered. The first type of penalty function assumes small values within the phase constraint and large values outside, whereas the second type is defined only within the phase constraints, assuming the small values away from the constraint boundary, but increasing to infinity as that boundary is approached. The bounded, or constrained-phase problem is replaced by a new problem in which the constraints are formally removed, but the cost functional is augmented by adding a penalty function of one of the above types. Solutions to this new problem are under suitable hypotheses, approximations to the solutions of the original constrained problem in the sense that as the severity of the penalty imposed increases without limit, these unconstrained solutions converge, in an appropriate sense, to solutions of the constrained problem. Author

N64-21060 Northwestern U., Evanston, Ill. Technological Inst.

QUASI-CONCAVITY, CCK DUALITY AND A GRADIENT INEQUALITY FOR NON-DIFFERENTIABLE FUNCTIONS

A. Charnes and K. Kortanek Feb. 1964 9 p refs

(Contract Nonr-1228(10))

(ONR-RM-92; AD-431890)

The extended dual equivalent of the "gradient" inequality for the nondifferentiable convex function f(x) is directly derived from the CCK (Charnes–Cooper–Kortanek) duality theory. It is assumed that $f(x) = a^T x + (x^T C x)^{1/2} \geq 0$ whenever $x \epsilon X = \{x | Ax \leq 0\}$, where C is symmetric and $x^T C x \geq 0$ on X. Then there exist $\pi \geq 0$ and z such that: (1) $Az \leq 0$; and (2) $\pi^T A + a + z^T C = 0$ and $z^T C z \leq 1$. The following problem is considered: min $a^T x + t$ subject to: $-Ax \geq 0$, $-x^T C x + t^2 \geq 0$, and $t \geq 0$. R.T.K.

N64-21068 California U., Berkeley Inst. of Engineering Research

DIVISIBLE ACTIVITIES IN CRITICAL PATH ANALYSIS

William S. Jewell 20 Feb. 1964 28 p refs

(ORC-64-3(RR))

A critical-path scheduling problem is investigated in which a single activity can have its completion time divided and allocated to different locations in the project precedence network. An algorithm for determining the allocation that minimizes total project duration is given, together with an outline of an optimality proof and an example. Although the algorithm is very similar to those used in network-flow-type problems, and uses only integer-valued variables, the final results for the divisible-activity network are, in general, rational numbers. Author

N64-21073 Air Force Systems Command, Griffiss AFB, N.Y. Rome Air Development Center

THE "SHIFT AND ADD PROPERTY" OF MAXIMAL LENGTH BINARY SEQUENCES USING CYCLOTOMIC POLYNOMIALS

Jack K. Wolf, Robert G. Mc Laughlin, and Frederick D. Schmandt Mar. 1964 24 p refs

(RADC-TDR-64-66; AD-600521)

A class of binary pseudorandom sequences called maximal-length shift register sequences are known to satisfy a "shift and add property," that is, if the sequence is shifted by K digits and added to itself, the resulting sequence is the original sequence shifted by R digits. This report presents a method for obtaining the parameter R for a given K and a given maximal-length sequence. This procedure makes use of previously published tables and the factorization of cyclotomic polynomials over Galois Field Two. Author

N64-21092 Michigan U., Ann Arbor Engineering Psychology Lab.

PROBABILISTIC INFORMATION PROCESSING IN COMMAND AND CONTROL SYSTEMS

Ward Edwards Mar. 1963 36 p refs

(Contract AF 19(604)-7393)

(ESD-TDR-62-345; Rept. 3780-12-T; AD-299291)

This report discusses the diagnostic function in command and control systems. It presents Bayes' theorem and examines its role in the design of command and control systems that process fallible information probabilistically. After summarizing existing relevant experimentation, the report points out major unsolved technical problems, and outlines a program of research for solving some of them. An examination is made of the feasibility and performance characteristics of such systems in a context that, while still experimental and abstract, is more realistic than that of the usual psychological experiment. Substantive questions to be studied in this experimental setting are listed, and the resources required for these experiments and for the broader research program are specified. Author

N64-21095 Michigan U., Ann Arbor Navigation and Control Systems Lab.

A FUNCTIONAL DECOMPOSITION FOR LINEAR DISCRETE SYSTEMS

W. A. Porter May 1964 13 p refs

(Contract DA-36-039-SC-78801)

(Rept. 2900-459-R; AD-600056)

In this study the linear difference equation

$$\Delta_k y(t_k) = A(t_k)y(t_k) + B(t_k)u(t_k) \qquad y(t_o) = y^o$$

is reduced to a canonical operator theoretic form. This representation consists of a parameterized family of bounded linear transformations into a cartesian product of the underlying scalar field. It gives immediate results for the minimum energy control problem. Author

N64-21111 RAND Corp., Santa Monica, Calif.

NUMERICAL SOLUTION OF FUNCTIONAL EQUATIONS BY MEANS OF LAPLACE TRANSFORM-I: RENEWAL EQUATION

R. E. Bellman, R. E. Kalaba, and J. Lockett Dec. 1963 18 p refs

(Grant PHS-GM-09608-02)

(RM-3948-NIH)

It was shown previously that it is possible to invert certain Laplace transforms numerically with speed and with accuracy. This technique is used to produce numerical solutions of the renewal equation $u(t) = f(t) + \int_0^t k(t-t_1)u(t_1)dt_1$. Author

N64-21144 Sperry Rand Corp., Blue Bell, Pa. UNIVAC Div.

INVESTIGATION AND ANALYSIS OF CIRCUIT COMPLEXES Final Report

John W. Hung, B. Kolman, I.E. Block, and T. J. B. Hannon 1 Dec. 1963 72 p refs

(Contract AF 19(628)-437)

(AFCRL-63-582; AD-600547)

The problem of self-repair can be broken down into several subproblems. The first of these is the checkout phase in which correct behavior is ascertained. The problem of fault diagnosis is considered. The function is first expressed in terms of a two-input NOR module, and then one obtains a decomposition tree for synthesizing all n-variable Boolean functions. The tree is obtained by expanding the function with respect to some number of variables. This tree enables one

to simulate malfunctions and to obtain the equivalence classes of faults. An example illustrates the procedure in detail. The sum part of the full adder is also used as an example to show the process of fault isolation, and the self-repair capability: By suitably redefining the input variables in the decomposition tree and inserting additional terminals, one can repair any single fault in the sum part of the full adder. Author

N64-21151 Wisconsin U., Madison Mathematics Research Center
MATRIX RICCATI DIFFERENTIAL EQUATIONS
W. J. Coles Mar. 1964 15 p refs
(Contract DA-11-022-ORD-2059)
(MRC-465; AD-600737)

The scalar Riccati equation $y' = p(t)y^2 + q(t)y+r(t)$ has the following well-known properties: (1) If one solution is known, the complete solution is obtainable by two quadratures. (2) If two solutions are known, the complete solution is obtainable by one quadrature. (3) The cross ratio of any four distinct solutions is constant. The scalar Riccati equation has been generalized to systems. Adoption of one or the other of two particular viewpoints leads to the matrix equations $u' = Au - u\alpha u$ (u is n × l) and $Y' = KY + L - YMY - YN$ (Y is n × m). This paper shows that there is an expression for the complete solution of equations of the first type, and that an expression for the complete solution of equations of the second type can be obtained by quadratures from the complete solution of the first type. Properties corresponding to (2) and (3) are established for the first equation. Author

N64-21156 Wisconsin U., Madison Mathematics Research Center
SYMMETRY AND ESSENTIAL SYMMETRY IN GRADUATED FIELDS
Walter Strodt Mar. 1964 25 p refs
(Contract DA-11-022-ORD-2059)
(MRC-468; AD-600738)

Let K_0 be a field of functions, each meromorphic in some sectorial neighborhood of ∞. For each $f \in K_0$, let f^* be defined by $f^*(x) = \overline{f(\bar{x})}$. A subfield F_0 of K_0 will be called essentially symmetric if for every $f \in F_0$ and every positive integer p there is an element g_p of F_0 such that $f^* - g_p\alpha x^{-p}$, where α has the meaning defined. The central result is the following theorem: If F_0 is essentially symmetric, so is the algebraic closure of F_0. This is proved in an abstract setting that uses and develops the author's theory of graduated fields. Author

N64-21161 RAND Corp., Santa Monica, Calif.
CHALLENGES OF MODERN CONTROL THEORY
Richard Bellman Jan. 1964 12 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3956-PR; AD-429351)

The fundamental objective of control theory is to modify a limited system by increasing the theory's effectiveness. In order to accomplish this, it is necessary to understand more fully those problems that the system must solve. Problem solving consists of recognition, formulation, analysis, computation, comparison, and reformulation, all linked together. Various mathematical approaches to control theory are reviewed. The direct applications of control theory to biology and medicine are discussed. G.D.B.

N64-21204 Iowa State U., Iowa City Ames Lab.
A TABLE OF $\sin^2\theta$ VERSUS θ AND 2θ
Frank S. Carlsen Mar. 1964 42 p ref
(Contract W-7405-ENG-82)
(IS-842) OTS: $1.00

A table of $\sin^2\theta$ vs θ and 2θ for θ from 0° to 89.995° in increments of 0.005° is presented. The methods of computation and checking of the results are also discussed. Author

N64-21210 Joint Publications Research Service, Washington, D.C.
TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY, NO. 78. FINITE AND INFINITE DIVERGENCE AND CONTINUITY
Hua Lo-Keng and Wang Yuan 16 Apr. 1964 41 p refs Transl. into ENGLISH from K'o Hsueh T'ung-Pao (Peiping), no. 12, 1963 p 4–21
(JPRS-24224; OTS-64-31085) OTS: $1.25

The fundamental mathematical philosophy in teaching the lower grades the background theories of infinite divergence and continuity is discussed. Arithmetic and algebra are branches of divergence, which also includes the modern digital electronic computers. In the middle grades, calculus (integral and differential) concerns the mathematics of the theories of the infinite and of continuity. The theory that bridges the gap between the above stages is also discussed. A.L.B.

N64-21217 RAND Corp., Santa Monica, Calif.
A SERIES EXPANSION FOR LOG $I_0(z)$, WITH APPLICATION TO DETECTION THEORY
Ivan Selin Mar. 1964 9 p refs
(P-2055-1; AD-432435)

In the problems described, it is desirable to have a series expansion with a known and simple general term for log $I_0(x)$, the modified Bessel function of the first kind. Since $I_0(x) = J_0(\sqrt{-1}\,x)$, the latter function is studied. The logarithm of the likelihood ratio for the detection of a high-frequency signal of unknown phase in the white normal noise studied is given by $z(y(t)) = \log L(y(t)) = -E/N_0 + \log I_0(\int_0^T \text{Envelope}\{y(t)\}\,\text{Envelope}\{s(t)\}dt) = -E/N_0 + \log I_0(r\sqrt{2E/N_0})$, where $2E/N_0$ is the energy ratio, y(t) is the received waveshape, s(t) is the expected signal, and r is a random parameter with a given probability density function. R.T.K.

N64-21219 California U., Berkeley
ON A CHANGE OF VARIABLES WHICH VARIES CONTINUOUSLY IN THE PERTURBATION PARAMETER Technical Report No. 4
Allen Kelley, Jr. Sep. 1963 16 p refs
(Contract Nonr-222(88))
(AD-431976)

Included in Professor S. P. Diliberto's lectures in 1963, at the University of Colorado, was the reduction of two-dimensional systems of ordinary differential equations in a neighborhood of a periodic solution to certain normal forms. The theorem presented in this report is the end process in a certain reduction. The problem in question is to find a change of variables that varies continuously in ϵ (perturbation parameter) in a neighborhood of $\epsilon = 0$. For ϵ fixed, other changes of variables (and normal forms) can be found. I.v.L.

N64-21329 Wisconsin U., Madison
APPLICATIONS OF THE CALCULUS FOR FACTORIAL ARRANGEMENTS II: UNEQUAL NUMBERS IN THE ANALYSIS OF VARIANCE Technical Summary Report
W. T. Federer and M. Zelen Mar. 1964 76 p refs
(Contract DA-11-022-ORD-2059)
(MRC-411; AD-600731)

This paper develops a new theory for the analysis of disproportionate numbers of observations in multifactor classifications. The principal theoretical result enabled a generalized

sum of squares in the analysis of variance to be written explicitly. Use of this result led to minimum calculations compared to other methods now in general use. A numerical example is presented that illustrates the calculations. Author

N64-21336 Stanford Research Inst., Menlo Park, Calif.
COMPUTER ROUTINE FOR POWER SPECTRAL DENSITY ANALYSIS BY THE MEB-PSD METHOD
G. L. Sutherland and L. J. Chaitin Apr. 1964 27 p
(ARPA-SD-103; ARPA Order 281-62)
(SRI-MR-8; AD-600288)

This report describes a computer routine that performs power spectral density analysis on a set of data. The routine is written in FORTRAN for the IBM-7090 computer. A synopsis of the method is presented, along with a printout of the program and results of a test case. Author

N64-21342 Bell Aerosystems Co., Buffalo, N.Y.
AERO-SPACE ENVIRONMENT SIMULATION SYSTEM (ASESS), VOLUME I: MASTER CONTROL PROGRAM AND PRESENTLY INCLUDED SUBROUTINES Final Report
Alfred D. Adler et al Bedford, Mass., L. G. Hanscom Field, ESD, Dec. 1963 330 p refs
(Contract AF 19(628)-2847)
(ESD-TDR-63-659, Vol. 1; AD-600186)

The primary objective was to design a system modeling, in real and fast time, the interactions of an array of space vehicles with the elements of the environment in which they exist, and containing detailed flow diagrams in the FORTRAN computer programing language for implementation on any one of several large-scale digital computers (the IBM 7030 being foremost). The system simulates an aerospace environment containing cooperative and uncooperative close-earth orbital vehicles, ground-based and spaceborne communications–telemetry systems, and ground-based search and tracking radars. Author

N64-21380 Innsbruck U. (Austria) Inst. of Mathematics
RESEARCH OF NONLINEAR BOUNDARY VALUE PROBLEMS USING THE METHOD OF LIE SERIES DEVISED BY GROBNER Final Technical Report, 1 Nov. 1963-31 Jan. 1964
W. Grobner and F. Cap 31 Jan. 1964 97 p refs
(Contract DA-91-591-EUC-2807)
(AD-432698)

The Lie series calculus has led to the discovery of a spectrum of iteration rules for the numerical treatment of differential equations. A new interpretation of the solving formulas is now possible, according to which the regularity of the system of differential equations no longer needs to be preassumed. For the numerical treatment of boundary-value problems these solving formulas are utilized for initial value problems and determine, with the aid of the Newtonian iteration method, the missing initial values from the prescribed boundary and intermediate conditions. In this way it is possible to attain a high degree of accuracy in the results. Author

N64-21391 RAND Corp., Santa Monica, Calif.
NUMERICAL SOLUTION OF FUNCTIONAL EQUATIONS BY MEANS OF LAPLACE TRANSFORM – II: DIFFERENTIAL-DIFFERENCE EQUATIONS
R. E. Bellman, R. E. Kalaba, and J. Lockett Dec. 1963 13 p refs
(Grant NIH GM-09608-02)
(RM-3952-NIH)

The aim of this report is to show that, with proper precautions, the numerical inversion of Laplace transforms is a valuable tool in the study of the linear differential-difference equation

$$u'(t) = au(t) + bu(t-\lambda), \quad t \geq 0$$
$$u(t) = g(t), \quad -1 \leq t \leq 0.$$

The study may be of use to control and circuit engineers and to numerical analysts. The methods are also useful in treating wide classes of equations arising in biology, chemistry, and operational research. N.E.A.

N64-21436 Naval Ordnance Lab., White Oak, Md. Mathematics Dept.
PROPERTIES OF WEAK SOLUTIONS OF CERTAIN SINGULAR INTEGRO-DIFFERENTIAL EQUATIONS
Avron Douglis Jun. 1964 54 p refs
(M-50; NOLTR-64-71; AD-600337)

Equations include time-dependent transport equations. The problem is for zero boundary data on a rectangular domain with given initial values. The weak solutions are shown to depend continuously upon and under certain conditions of positivity that can be ordered like their initial data. The first derivatives are estimated from initial data. Author

N64-21437 Research Triangle Inst., Durham, N.C. Statistics Research Div.
DESIGN AND ANALYSIS OF EXPERIMENTS TO DETERMINE EFFECTS OF FACTORS ON RESPONSE VARIABLES Final Report, 6 Feb. 1962-30 Apr. 1964
Sidney Addelman [1964] 7 p refs
(Grant DA-ARO(D)-31-124-G266)
(AROD-2579-17; AD-440358)

Abstracts of the following reports are presented: (1) "Augmenting Factorial Plans to Accommodate Additional Two-Level Factors"; (2) "Techniques for Constructing Fractional Replicate Plans"; (3) "Student's t in a Two-Way Classification with Unequal Variances"; (4) "A Procedure for Constructing Incomplete Block Designs"; (5) "Fractional Replication in Split-Plot Experiments"; (6) "Designs for the Sequential Application of Factors"; and (7) "Proportional Frequency Designs." Also, current research in the following areas is discussed: (1) a modification of the Latin Square Design; and (2) an investigation on the problem of discriminating between two or more mathematical or empirical models. The two aspects of this problem that are being considered are those of designing the best experiment for selecting the correct model, and of using an efficient statistical procedure for discriminating between the models. I.v.L.

N64-21439 Air Force Inst. of Tech., Wright-Patterson AFB, Ohio Flight Dynamics Lab.
DIGITAL COMPUTER PROGRAM FOR THE ANALYSIS OF AEROSPACE STRUCTURES BY THE MATRIX DISPLACEMENT METHOD Summary Report, 10 Jan. 1962-15 Jul. 1963
J. S. Przemieniecki and Laszlo Berke Apr. 1964 116 p refs
(FDL-TDR-64-18; AD-600518)

This report presents a detailed development of the matrix displacement method and describes an available computer program that can be used for the stress and deflection analysis of arbitrary structures idealized into an assembly of axial load members (bars), triangular panels, rectangular panels with linearly varying edge displacements, and rectangular panels with an assumed (Turner) stress distribution. Only the translational degrees of freedom are considered in this program. Five different loading conditions may be analyzed simultaneously, and for each condition a separate temperature distribution may be specified. A description of the digital analysis,

instructions for the use of the available program, and an illustrative analysis problem are presented. Author

N64-21448 New York U., N.Y. Laboratory for Electroscience Research
CUMULATIVE CODES AS VARIABLE REDUNDANCY CODES Fifteenth Scientific Report
Jack Keil Wolf Dec. 1963 26 p refs
(Contract AF 19(604)-6168; Grant AF-AFOSR-499-64)
(TR-400-87; AFCRL-64-11; AD-600009)

A cumulative decision feedback system is considered whereby the digits are decoded on the basis of all the digits in all of the repeated blocks. If an (n,k) binary group code is repeated (N−1) times, the resultant digits are considered as nN-tuples derived from an (nN,k) code. The parity check matrix, minimum distance, and generator polynomial (for cyclic codes) are determined for the (Nn,k) codes in terms of the respective quantities for the (n,k) code. A method for partitioning the error detection and correction capabilities of the (Nn,k) code is suggested on the basis of a constant fail-safe probability criterion. Author

N64-21460 Northrop Corp., Anaheim, Calif. Nortronics Div.
DEVELOPMENT OF TECHNIQUES FOR PREDICTION OF SYSTEM EFFECTIVENESS Final Report
John C. O'Brien 25 Jan. 1963 113 p refs
(Contract AF 30(602)-2730)
(NSS-2360; RADC-TDR-62-540; AD-296326)

This report presents a novel and effective solution to the problem of quantifying system quality. Techniques for prediction of future performance quality are developed in detail. The power of the mathematical and physical modeling developed in this study (called SPAN—System Performance Analysis), is due to the use of a comprehensive metric of performance, comprising both energy and "bound" information measures. SPAN's ability to integrate these factors into a consistent performance descriptor is based on well-known laws of potential energy and probability theory. A calculus of system performance dynamics, compatible with the SPAN metric, is directly obtainable from Laplace's and Helmholtz' equations for energy flow, by inserting the information content of the constraining pattern. The feasibility of simulating a system defined in SPAN terminology by an electrical network is demonstrated. Author

N64-21466 Catholic U. of America, Washington, D.C. Stress Analysis Lab.
DEVELOPMENT OF EXPERIMENTAL STRESS ANALYSIS METHODS TO DETERMINE STRESSES AND STRAINS IN SOLID PROPELLANT GRAINS. EXPERIMENTAL SOLUTION OF SOME MIXED BOUNDARY VALUE PROBLEMS
A. J. Durelli and V. J. Parks Apr. 1964 88 p refs Presented at an Eng. Colloq., Brown U.
(Contract Nonr-2249(06))
(IR-4; AD-600546)

This paper deals with means of applying known displacements and known stresses to the boundaries of models used in experimental stress analysis. Reviewed is the solution of several problems in which these means are used. The evaluation of the stresses, strains, and displacements in the field is conducted using several experimental stress analysis methods. Particular emphasis is placed on the methods used to study several kinds of shrinkage problems with two- and three-dimensional photoelasticity. The application of these methods is illustrated with examples, several of which are in the field of stress analysis of solid-propellant grains. Author

N64-21478 California U., Livermore. Lawrence Radiation Lab.
COMPLEX: A LEAST SQUARES METHOD FOR FITTING QUADRATICALLY INTERPOLATED TABLES TO A TWO-DIMENSIONAL DATA ARRAY
Richard H. White 30 Jan. 1964 19 p
(Contract W-7405-ENG-48)
(UCRL-7687) OTS: $0.50

The problem of presenting equation-of-state data (pressures and energies as functions of temperatures and densities) in a form amenable to calculations on a digital computer has been solved by tabulating the functions on a rectangular grid and interpolating quadratically in both independent variables in order to find values of the function at points off the table grid. This report describes the method that has been used to fit such tables to a large data array. The computer program that performs these calculations has been called COMPLEX (a least squares method for fitting quadratically interpolated tables to a two-dimensional data array). J.L.D.

N64-21479 RAND Corp., Santa Monica, Calif.
AUTOSATE
O. T. Gatto Jan. 1964 19 p Presented at the 3d Ann. Tech. Symp., Sponsored by San Francisco Bay Area Chapter of ACM, 1 Nov. 1963
(P-2646-1)

The AUTOSATE, an automated data-systems-analysis technique, has been designed to solve the problem of determining what to do with all the data gathered. It is carried out in three phases: (1) documenting system data flows through interviews, in much the same manner as conventional system analysis is performed; (2) controlling, editing, and translating the system specifications into a machine-readable form; and (3) preparing a series of analysis reports by computer. The AUTOSATE differs from the usual system analysis in that the area of analysis is segmented into stations rather than into applications. Stations are the nodes in a data-system network in which data activity in and out, as well as the information retained at a station, is identified. Specifically, with AUTOSATE, system analysis is geared to: (1) determining the characteristics of different stations; (2) determining the relationships of stations with one another; and (3) locating and analyzing the major data-storage points in the information network. J.L.D.

N64-21487 Brown U., Providence, R.I.
OPTIMAL PROGRAMS FOR SEQUENTIAL INVESTMENTS Technical Report No. 1
David Gale 1964 13 p
(Contract Nonr-562(15))
(AD-433699)

The customary analysis of a sequential investment assumes the existence of a positive external interest rate. The supposition is that if there were no such thing as interest, or if the interest rate were zero, is there still some natural way to compare the profitabilities of various sequential investments? A concrete example is cited wherein two investment processes are presented to determine whether there is any reason to consider one of the investments more profitable than the other, even in a world in which money accrues no interest. N.E.A.

21 METEOROLOGY

Includes climatology; weather forecasting; and lower atmosphere studies. *For related information see*: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N64-20828 Stanford Research Inst., Menlo Park, Calif.
METEOROLOGICAL INTERPRETATION OF SATELLITE CLOUD PHOTOGRAPHS Final Report
Rex G. Hadfield, Eldon J. Wiegman, William Viezee, and Sidney M. Serebreny Jan. 1964 105 p refs
(Contract Cwb-10481)

The meteorological interpretation of satellite cloud photographs was investigated through a series of Tiros III orbits over the North Atlantic. The photographs were poor, and interpretations were based on cloud cover patterns. The cloud cover enabled recognition of major frontal bands, postfrontal areas, large scale vortices, and well-developed ridges or high cells. The vertical motion and changes in cloud cover were studied for two stations using the adiabatic method. Time sections of these parameters indicated that there was good correspondence between upward motion and a small difference between temperature and dew point difference, except near frontal boundaries. Upward motion is observed in a prefrontal area, downward motion through a deep layer within frontal boundaries, and upward motion in the postfrontal area. The direction of the large-scale vertical motion is dependent on the backing or veering of wind with height. The interrelationship of pressure patterns, cloud patterns, jet streams, and types of temperature soundings is generalized into three regimes and presented in schematic form. Author

N64-20936 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
WEATHER REQUIREMENTS FOR ALL-WEATHER LANDING SYSTEM
In its Second Intern. Aviation and R&D Symp.: All-Weather Landing Systems [1963] p 117–136 (See N64-20932 14-22)

The weather measurements required for operations at 100-ft and 1/4-mile visual distance are considered. Transmissometers at touchdown points and rotating-beam ceilometers at middle marker sites (now installed or programed to be installed this year) at 254 civil fields and almost 100 military bases throughout the United States are described. R.T.K.

N64-21083 Oslo U., Blindern (Norway) Inst. of Theoretical Meteorology
A COMPUTATION OF THE VERTICAL CIRCULATION IN A FRONTAL ZONE FROM THE QUASI-GEOSTROPHIC EQUATIONS Technical Note No. 4
M. Todsen 8 Jan. 1964 25 p refs
(Contract AF 61(052)-525)
(AFCRL-64-246; AD-600368)

The diagnostic differential equation for the stream function of the nongeostrophic motion in a frontal zone is solved numerically from observed data of a cold front. The effect of condensation on the vertical circulation is considered. The picture of the total transverse motion shows that both cold and warm air take in the ascent along the front. Author

N64-21113 RAND Corp., Santa Monica, Calif.
SIMPLE MODELS OF THERMALLY DRIVEN MESOSPHERIC CIRCULATION
Conway Leovy (M.S. Thesis-MIT) Jan. 1964 51 p refs
(P-2847)

Possible thermally driven symmetric circulations of the mesosphere and upper stratosphere are considered, subject to the assumption that: (1) The motions are in hydrostatic and geostrophic balance. (2) The motions are small perturbations about a state of rest defined by the horizontal average of the radiative equilibrium temperature. (3) The eddy fluxes of momentum and heat act only as Rayleigh friction and Newtonian conductivity, or as vertical eddy viscosity and conductivity. The assumption of small perturbations is justified by consideration of photochemical and radiative processes. Author

N64-21300 RAND Corp., Santa Monica, Calif.
ELECTROSTATIC FORCES AND CLOUD-DROPLET INTERACTION
M. H. Davis Mar. 1964 11 p
(P-2885; AD-433239)

The purpose of this investigation was to study electrostatic effects on cloud-droplet trajectories, coalescence, and charging. The case of droplet interactions in warm clouds where droplet radii are less than 25 microns was investigated. Under these conditions, Hocking's solution to the hydrodynamic forces was found to be valid and was used. The electrostatic forces were computed for separations greater than the radius of the larger drop by the "charge-and-dipole" approximation. The assumption that cloud droplets can be treated as conducting spheres was critically examined and appears valid. R.T.K.

N64-21308 Stanford Research Inst., Menlo Park, Calif.
THE DISTRIBUTION OF CLEAR AIR TURBULENCE REPORTS AND CLOUD PATTERNS AS SEEN IN SATELLITE PHOTOGRAPHS Final Report
Sidney M. Serebreny and Eldon J. Wiegman Jan 1964 49 p refs
(Contract Cwb-10481)
(AD-432468)

Selected COMBAR reports of clear air turbulence for 10 days are studied in association with the cloud distribution shown by TIROS I. Characteristic cloud patterns accompany certain types of weather systems, particularly low-pressure vortices, and often delineate, rather well, the location of jet streams and tropopauses about these weather systems. As a consequence, satellite photographs of low pressure vortices may provide a useful supplemental tool in establishing the areal distribution of clear-air turbulence risk during various stages of cyclone development. Schematic representations of the typical cloud patterns during three stages of cyclone development are presented. Four case histories are included as characteristic examples. Author

N64-21402 Texas A. and M. Research Foundation, College Station
RESEARCH ON TROPICAL RAINFALL PATTERNS AND ASSOCIATED MESO-SCALE SYSTEMS Fourth Quarterly Progress Report, 1 Aug.-31 Dec. 1963
Walter K. Henry and John F. Griffiths 15 Jan. 1964 57 p refs
(Contract DA-IAO-11001-B-021-09)
(AD-432405)

A study of the areal variations of rainfall in the Panama–Costa Rica area shows the extreme variation of rainfall. Also the daily variations from station to station and from day to day are discussed. Using data from two Central America stations with long periods of records, various methods have been attempted whereby the start, finish, and duration of the rainy season may be calculated. One of these, using a simple water balance technique, gives sensible and consistent results, and the analyses for the two stations are presented. Author

N64-21434 Texas U., Austin Electrical Engineering Research Lab.
OPERATION AND PERFORMANCE OF THE CEDAR HILL METEOROLOGICAL TOWER FACILITY Final Report
W. S. Mitcham and K. H. Jehn 31 Jan. 1964 49 p refs
(Contract AF 19(628)-2459)
(Rept.-4-10; AFCRL-64-306; AD-600235)

Acquisition of wind and temperature data over a range of heights extending from 30 to 1,421 feet above ground level was carried on at Cedar Hill Tower Meteorological Research Facility from 1960 to 1963. The purpose of this report is to provide an evaluation of the performance of the data acquisition system, month-by-month, over its entire lifetime and to describe, in detail, the procedures that were evolved for monitoring the technical aspects of the system. A summary of recent investigations relating to the low-level jet is given. Author

N64-21492 Air Weather Service, Washington, D.C. Headquarters 4th Weather Group
INFRARED TECHNOLOGY AND AEROSPACE SYSTEMS Lecture Series
Harold A. Steiner 1 Mar. 1964 36 p refs Presented to AF Aerospace Res. Pilots School, Edwards AFB
(Rept.-4-WGP-80-3-1; AD-434323)

A discussion is presented of the basic elements of infrared technology, in particular those elements that are affected by the earth's atmosphere. Infrared physics, as it pertains to maximum emissions from well-known objects in aerospace, and gross effects of atmospheric constituents on infrared techniques used in aerospace systems are also discussed. It is pointed out that these effects are either detrimental or beneficial, depending on the mode of operation of the system. P.V.E.

22 NAVIGATION AND GUIDANCE

Includes autopilots; star tracking; inertial platforms; and air traffic control. *For related information see*: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities, Research and Support; 15 Instrumentation and Photography; 20 Mathematics; and 29 Space Sciences.

N64-20932 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
SECOND INTERNATIONAL AVIATION R&D SYMPOSIUM: ALL-WEATHER LANDING SYSTEMS Summary of Discussions and Program Progress Report
[1963] 191 p Symp. held at Atlantic City, 16–18 Sep. 1963

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N64-20933 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
FAA ALL-WEATHER LANDING PROGRAM
In its Second Intern. Aviation R&D Symp.: All-Weather Landing Systems [1963] p 69–77 (See N64-20932 14-22)

The objective of the Systems Research and Development Service of the Federal Aviation Agency (FAA) is the reduction of weather minima for aircraft operations. The scope of the FAA All Weather Landing Program and the present status of the program are outlined. R.T.K.

N64-20937 Federal Aviation Agency, Washington, D.C. Systems Research and Development Service
VISUAL AIDS SYSTEM FOR ALL-WEATHER OPERATIONS
In its Second Intern. Aviation R&D Symp.: All-Weather Landing Systems [1963] p 137–154 (See N64-20932 14-22)

A discussion is presented of the problem of designing a system with configuration and light distribution sufficiently distinctive so that the pilot can readily recognize his position, and can receive continual visual guidance from the point where any segment of the system first comes into view. R.T.K.

N64-20950* National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala.
SPACE FLIGHT AND GUIDANCE THEORY: INTRODUCTION
In its Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 1–7 (See N64-20949 14-01)

A summary of the progress reports of NASA-sponsored studies in the areas of space flight and guidance theory is presented. The major fields of interest covered are calculus of variations, impulse orbit transfer, matrix operations, large-computer exploitation, stability, and low-thrust trajectories. R.T.K.

N64-20952* Auburn U., Ala.
AN INVESTIGATION OF MINIMUM DRAG ATMOSPHERIC RE-ENTRY PATHS
Grady Harmon and W. A. Shaw *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 37–81 refs (See N64-20949 14-01)

The Maximum Principle of Pontryagin was used to find the point-to-point reentry trajectory of a space vehicle with an offset center of gravity to minimize the accumulated aerodynamic acceleration. The mathematical model used incorporated the yaw angle-of-attack as the control variable and eliminated undesirable oscillations due to time variations of the rotation state variables. The set of characteristic differential equations was written with the first-order equations of motion as constraints. A computation procedure was devised so that numerical solutions can be obtained on a digital computer. Author

N64-20953* Analytical Mechanics Associates, Inc., Uniondale, N.Y.
AN OPTIMAL GUIDANCE APPROXIMATION THEORY
Henry J. Kelley Jan. 1964 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 83–95 refs (See N64-20949 14-01)
(Contract NAS8-5314)

Synthesis of optimal guidance approximations is undertaken by means of a perturbation theory approach. A simple example is treated analytically, and an approximation for the optimal control, including linear and quadratic feedback terms in the state deviations from an optimal reference trajectory, was obtained. Author

N64-20960* North Carolina U., Chapel Hill Computation Center
INVERSE ESTIMATION
G. W. Adkins *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 209–221 refs (See N64-20949 14-01)

The procedures employed are briefly described in the application of inverse estimation to problems in experimental design; how this technique might be applied in the development of guidance function approximations is shown, and the problem areas that must be investigated for such an application are indicated. Author

N64-21093 Giannini Controls Corp., Malvern, Pa. Astromechanics Research Div.
FLEXIBLE FLIGHT VEHICLE TRANSFER FUNCTION FACTORS FOR USE IN AUTOPILOT PRELIMINARY DESIGN Technical Documentary Report, 15 Mar. 1962–31 May 1963
A. G. Fonda and F. J. Trueh Wright-Patterson AFB, Ohio, Res. and Technol. Div., Apr. 1964 167 p refs
(Contract AF 33(657)-8456)
(RTD-TDR-63-4218; AD-600672)

This report presents a series of charts of forward-loop transfer function poles and zeroes for a general flight vehicle having both rigid and elastic longitudinal degrees of freedom. These charts allow an assessment to be made, early in the design of an autopilot–airframe system, of the influence of flexibility and modal interaction upon the system's dynamic response. In addition to the numerical approach made possible by this report, the charts and accompanying theory provide a technical foundation for understanding the cause-and-effect relationship between the design and the dynamic behavior of a flexible flight vehicle. A method of interpolation between charts also results from the theory presented and permits application of the design chart data to a multitude of flexible flight vehicle configurations. Author

N64-21098 Michigan U., Ann Arbor Navigation and Control Systems Lab.
A SETTLING TIME CONSTRAINED OPTIMIZATION OF A VELOCITY INERTIAL NAVIGATION SYSTEM
W. A. Porter and M. Kuo May 1964 22 p refs
(Contract DA-36-039-SC-78801)
(Rept. 2900-464-R; AD-600140)

This memorandum describes a technique for improving transient performance in the velocity inertial system while minimizing the standard deviation of the system error (for example, the standard deviation of the system velocity measurement error σ_v^2). To accomplish this, a prescribed settling-time constraint is formulated for the system response, and the constraint equation is then imposed on the minimization process. The result shows that considerable settling-time improvement can be derived without sacrificing system accuracy. Author

N64-21185 Radio Corp. of America, Camden, N.J. Defense Electronic Products
DOPPLER OPTICAL NAVIGATOR Third Quarterly Progress Report, 6 Dec. 1963–6 Mar. 1964
W. J. Hannan, L. J. Nicastro, T. E. Penn, and J. Vollmer 20 Mar. 1964 59 p refs
(Contract AF 33(657)-11458)
(AD-434227)

The objective of this program is to determine the feasibility of novel laser techniques for Doppler optical navigation. The performance goal is the measurement of ground speed of a satellite, traveling at a velocity of 10,000 m/sec at an altitude of 300 miles, with an accuracy of 5 m/sec. For the velocities involved, the optical Doppler shift can be as high as 20 Gc, which is beyond the state-of-the-art of tracking receivers. For this reason subcarrier modulation techniques were investigated. Analysis of the subcarrier case, which takes into account atmospheric attenuation, solar background radiation, coherence of the subcarrier return, and practical system constants, indicates that required transmitter power is more than an order of magnitude beyond the present state-of-the-art of laser transmitters. Assuming that the power required becomes available, it is important to note that the subcarrier approach is feasible for high altitudes. Investigation of the subcarrier approach to low-altitude aircraft reveals that it offers little, if any, improvement over conventional microwave systems. However, a CW system employing an optical heterodyne receiver does offer potential advantages. Operation of a thermoelectrically cooled gallium–arsenide laser transmitter was demonstrated. This refrigeration technique makes injection lasers practical. Author

N64-21320 Naval Weapons Lab., Dahlgren, Va.
NEW TECHNIQUES FOR COMPUTING LORAN MAPS
A. V. Hershey and E. J. Hershey 21 Jan. 1964 46 p refs
(NWL-1902; AD-438941)

A pre-existing program for plotting section lines of a ship has been adapted to the contouring of loran maps. The method is based on approximations of the square of geodesic time difference to avoid singularities at the transmitting stations. Maximum errors are tabulated for a few representative maps. Author

23 PHYSICS, GENERAL

Includes acoustics; cyrogenics; and optics. *For astrophysics see*: 05 Astronomy and Astrophysics. *For related information see*: 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 25 Physics, Solid-State.

N64-20800* General Electric Co., Pleasanton, Calif. Valecitos Atomic Lab.
SPECIAL TOPICS. C: RADIATION EFFECTS
Leo F. Epstein *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 101–104 refs (See N64-20783 14-01) OTS: $5.00

Protective layers exposed to bombardment of radioactive particles spall or slough off, or suffer cracks and flaws. Quantitative evaluation of these indicates that radiation acceleration of corrosion by liquid metals is of negligible importance. A.W.

N64-20802* General Dynamics/Astronautics, San Diego, Calif.
SURFACE ENERGY PHENOMENA AND CORROSION
Robert J. Good *In* NASA. Lewis Res. Center Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 107–125 refs (See N64-20783 14-01) OTS: $5.00
(Contract AT(04-3)-297)

For two substances having the same type of cohesive forces, the free energy of adhesion should be approximately the geometric mean of the free energies of cohesion of the separate phases. This theory is discussed through the formulation and testing of specific equations. Applications are made to corrosion phenomena. Caution is urged in applying the interface theory to the corrosion of alloys. A.W.

N64-20813* Philco Corp., Blue Bell, Pa. Scientific Lab.
THEORETICAL AND EXPERIMENTAL INVESTIGATION ON MODULATION INDUCING RETRODIRECTIVE OPTICAL SYSTEMS Monthly Progress Report No. 11, 21 Mar.-1 May 1964
B. W. Harned 14 May 1964 7 p refs
(Contract NASw-721)
(NASA CR-56172) OTS: $1.10 ph

Preliminary attempts to observe transmitted light in the cesium optical-pumping experiment with high-resolution equipment have successfully shown the desired variations in intensity of the transmitted pumping light when the magnetic field is varied. Radiofrequency resonances in the excited state were sought without success when making use of D_2 radiation in pumping and cross modulation. The use of free carrier absorption as a modulation-inducing retrodirective optical-systems (MIROS) principle was further investigated. It was concluded that the concept of cross modulation using free carrier absorption is practicable in the laboratory; where high photon fluxes are possible, but virtually impossible in cw operation for long-distance satellite optical-communications work. Also, a paper by the Russian scientists, E. B. Alexandrov and V. A. Kchodovoj, on field-reversal effects in optical pumping is discussed. These authors contend that an experiment using field reversal to measure relaxation times of the pumped atoms is not meaningful unless stray fields are canceled. I.v.L.

N64-20822 Illinois U., Urbana Charged Particle Research Lab.
PARAMETERS INFLUENCING THE CHARGE-TO-MASS RATIO OF ELECTRICALLY SPRAYED LIQUID PARTICLES
James J. Hogan 15 Dec. 1963 143 p refs
(Grants AF-AFOSR-107-63; NSF G-19776)
(CPRL-2-63)

The problem in this study was to investigate the parameters influencing and the mechanisms involved in the electrical atomization process, i.e., in the process by which liquid surfaces are broken up into small, charged particles as the result of electrostatic forces. Electrical atomization was studied primarily by measuring the charges, masses, velocities, and charge-to-mass ratios (specific charge) of the particles in the beams thus generated. A theoretical study of the electrical dispersion process is presented. The study includes surface energy minimization of the dispersed system of particles, solution of Poisson's equation and the influence of space charge on the specific charge of the emitted particles, and the influence of the conductivity and temperature of the liquid on the generation of charged particles. Author

N64-20826 Los Alamos Scientific Lab., N. Mex.
ANISOTROPIC SCATTERING APPROXIMATIONS IN THE BOLTZMANN TRANSPORT EQUATION
Kaye D. Lathrop 13 May 1964 106 p refs
(Contract W-7405-ENG-36)
(LA-3051) OTS: $2.25

The effect of anisotropic scattering upon solutions of two elementary problems of monoenergetic neutron transport was examined. Solutions to the infinite homogeneous medium problem for a medium containing isotropic and anisotropic scatterers and a fission source, in which the diffusion length appears as an eigenvalue, were derived for several scattering approximations. Solutions were also derived for the spatially dependent neutron flux in the problem of a plane source in an infinite medium. In each problem, examination of an exact solution for an anisotropic scatterer with purely forward and backward scattering was illuminated. The relative effectiveness of the scattering approximations developed is evaluated numerically, and extensive tables of solutions for elastic hydrogen scattering are tabulated for reference. In overall effectiveness, in order of increasing accuracy, the approximations considered are ranked as follows: (1) transport, (2) forward-backward, (3) first-order Legendre, (4) extended transport, and (5) higher-order Legendre, scattering approximations. Author

N64-20832 Hahn-Meitner-Institut für Kernforschung, Berlin (W. Germany)
INTERPRETATION AND EVALUATION OF NON-IDEAL GAS RELEASE IN POST-ACTIVATION MEASUREMENTS (RARE-GAS DIFFUSION IN SOLIDS 11)
T. Lagerwall and P. Schmeling Brussels, European Atomic Energy Community, Feb. 1964 51 p refs
(Contract EURATOM-094-62-9 RDD)
(EUR-595.e; EURAEC-806) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 70 Belg. Fr.

This report gives a review of possible causes of the non-ideal gas release kinetics often observed in postactivation diffusion experiments. In the calculation of diffusion coefficients from the corresponding release curves, D-values that may be different by orders of magnitude will come out, depending on different interpretation of the experimental curve. This may contribute to the uncommonly broad scattering of the values of diffusion coefficients found in the literature and shows that a deeper insight of the underlying physical processes is needed to evaluate the experimental data correctly. On discussing present experimental results, different assumptions regarding the nature of these processes are made, and the consequences for the experimentally observed release patterns are discussed. Recommendations are given for the evaluation of complicated release curves. Author

N64-20836 Argonne National Lab., Ill. Solid State Science Div.
FIELD EMISSION FROM SINGLE CRYSTALS OF GRAPHITE
G. Montet, M. Hoch, and G. Hennig Feb. 1964 18 p refs
(Contract W-31-109-ENG-38)
(ANL-6804) OTS: $0.50

The surface conditions of graphite were studied with a field-emission microscope. The emitting tips were "knife-edges" of graphite platelets made by a technique developed in this laboratory. The emissions characteristic of clean edges and of edges covered by an oxide film were studied, and some qualitative information of relative work functions of these surfaces was obtained. Attempts to extend these observations are described. Author

N64-20840 Technion Research and Development Foundation Ltd., Haifa (Israel)
RESEARCH ON ELECTROMAGNETIC NOISE AT EXTREMELY LOW FREQUENCIES Summary Report No. 1, Aug. 1961-May 1963
N. Robinson and U. Galil [1963] 8 p refs
(Contract AF 61(052)-555)
(AFCRL-64-352; AD-439640)

The work on electromagnetic noise at extremely low frequencies was carried out in three ways: (1) measurement of VLF electromagnetic noise at 5 kcps; (2) theoretical analysis on magneto-ionic mode propagation in the ionosphere and profiles of the ionosphere; and (3) experiments with various low-noise circuits for receiving signals in the VLF range. Author

N64-20844 Uppsala U. (Sweden) Quantum Chemistry Group

THE DIRECT DETERMINATION OF NATURAL ORBITALS AND NATURAL EXPANSION COEFFICIENTS OF MANY ELECTRON WAVE FUNCTIONS. I: NATURAL ORBITALS IN THE GEMINAL PRODUCT APPROXIMATION Scientific Report No. 7

Werner Kutzeinigg 1 Jan. 1964 22 p refs

(Contract AF 61(052)-701)

(ARL-64-99; Preprint-112; AD-600166)

The approximation of a many particle wave function as an antisymmetrized product of strongly orthogonal geminals (APSG) (geminal means two-electron function) is analyzed in terms of its natural expansion. APSG wave functions have very simple and interesting properties. The generating spin geminals (GSG) are automatically natural spin geminals (NSG) of the system with occupation number 1 (in the Löwdin normalization); 1 is the upper bound for the eigenvalues of the 2-particle density matrix for wave functions of this type. The natural spin orbitals NSO of the GSG are automatically NSO of the total wave function and of all the NSG. A generalized paired orbital function is defined in terms of its natural expansion. It contains the APSG type as well as the Bardeen–Cooper–Schrieffer (BCS) functions as special cases. Integro-differential equations determining the NSO and their expansion coefficients for an APSG function are derived for the special case of a singlet state by minimizing the total electronic energy. An iterative resolution procedure is proposed. When the state under consideration can be regarded as a closed shell state the first iteration step may already be a good approximation. In this case, the equations become very simple and can be given a straightforward physical interpretation. Author

N64-20861 Naval Radiological Defense Lab., San Francisco, Calif.

CALCULATION OF TRAJECTORIES AND PROPERTIES OF SLURRY FALLOUT PARTICLES FROM WATER-SURFACE NUCLEAR BURSTS

S. Baum, D. Freund, and M. Hogan 28 Feb. 1964 66 p refs

(USNRDL-TR-724; AD-438420)

A program has been developed for computing the trajectories and changing properties of salt-slurry fallout particles resulting from a sea water-surface nuclear explosion. The computed results are compared with earlier calculations and with measurements of particle characteristics vs arrival time from a large-yield water-surface nuclear explosion. Author

N64-20873 European Atomic Energy Community, Brussels (Belgium)

REACTOR KINETIC BEHAVIOR AND MOTION PICTURE DOCUMENTATION OF THE DESTRUCTIVE TEST

A. Sola, R. Scott, Jr., R. K. Mc Cardell, and E. Feinauer (Phillips Petroleum Co.) Joint Nucl. Res. Center, ISPRA Establ. (Italy) Reactor Phys. Dept., Mar. 1964 10 p Presented at the Am. Nucl. Soc. 9th Ann. Meeting, Salt Lake City, 17–19 Jun. 1963

(EUR-497.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 25 Belg. Fr.

This paper presents some of the results obtained during the nondestructive test series of the SPERT I reactor. The data discussed are those of transient power, energy, fuel plate surface temperature, pressure power burst profile, and extent of core damage resulting from each test. The conditions existing during the destructive test are equally presented. Author

N64-20879 European Atomic Energy Community, Brussels (Belgium)

CALCULATION OF D_2O MODERATED LATTICES BY BASIC METHODS

B. Sturm Joint Nucl. Res. Center, ISPRA Estab. (Italy), Mar. 1964 32 p refs Presented at Convegno di Fisica dei Reattori, Milan, 29–30 Nov. 1963

(EUR-597.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 50 Belg. Fr.

For the calculation of D_2O-moderated, organic-cooled natural uranium lattices, a calculational procedure is proposed on the refined reactor codes available at Ispra. For the calculation of fast group constants the GAM-I multigroup program was used. By weighting factors to take into account the heterogeneity of the lattice, cells were calculated by the DSN program for macrocells and microcells. For the calculation of thermal cross sections the THERMOS-code was used and the disadvantage factors for the different materials in the cell were obtained by a one group calculation using the DSN program. On the basis of this procedure an analysis of critical experiments done by AECL for a $7UO_2$ rod-organic cooled fuel element, was performed. Reasonable agreement was found for material buckling as well as for measured thermal disadvantage factors, initial-conversion ratio, and fast-fission ratio. Author

N64-20880 European Atomic Energy Community, Brussels (Belgium)

CAPRI A. B. – AN I.B.M. 7090 THERMAL UTILIZATION FACTOR CALCULATION PROGRAM ON THE RING METHOD OF AMOUYAL AND BENOIST

W. De Haan Joint Nucl. Res. Center, ISPRA Estab. (Italy), Mar. 1964 18 p refs

(EUR-1606.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

This program calculated the thermal utilization factor of a lattice cell consisting of, at most, 20 regions. The formulation closely followed the method developed by Amouyal and Benoist. The basic assumptions of this method are that isotropic flux of neutrons enters the regions at their boundaries, and that collision density of neutrons after first collision is constant in the region. Only in the central region can a factor be introduced to correct the error due to the second assumption. In the outermost region the diffusion method is normally used. Use of the former method in this region is optional. A layout of the formulation is given in the text, together with the input and output specification. Organization of the program, input, and output are illustrated. Author

N64-20882 European Atomic Energy Community, Brussels (Belgium)

STATISTICAL STUDY OF THE EFFECTS OF MEASUREMENT ERRORS ON THE EXTRAPOLATED RADIUS AND HEIGHT CALCULATION FOR A CYLINDRICAL REACTOR

M. Cocchi and G. Di Cola Joint Nucl. Res. Center, ISPRA Estab. (Italy) Sci. Data Process. Center, Mar. 1964 10 p refs

(EUR-1624.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 25 Belg. Fr.

The effects of the measurement errors on the extrapolated radius and height calculation were determined by a statistical analysis using the Monte Carlo method. Random uncorrelated errors were considered to exist simultaneously in the placing of detectors and in flux measurements. The measurement errors were assumed to be normally distributed. The extrapolated radius and heights were calculated using the gauss iterative method for nonlinear best-fit problems. The probable effects of the random errors were demonstrated through mean values and standard deviation of the corresponding probability and distribution curves for a few nominal reactors. Author

N64-20885 Los Alamos Scientific Lab., N. Mex.
CRITICAL DIMENSIONS OF URANIUM (93.5)-GRAPHITE-WATER SPHERES, CYLINDERS, AND SLABS
William R. Stratton 28 Oct. 1963 36 p refs
(Contract W-7405-ENG-36)
(LAMS-2955) OTS: $0.75

A parametric study of the critical dimensions of U(93.5)-graphite-water spheres, slabs, and cylinders is presented. The data were obtained by application of the LASL DSN code and include five different loadings of uranium in graphite; the range of moderation as caused by water is complete. Both unreflected and water-reflected systems are considered. Author

N64-20888 Avco Corp., Tulsa, Okla. Environmental Physics Lab.
THE "ION-METAL FILM" PHENOMENON Status Report
K. G. Young, Jr. and M. I. Gamble 31 Oct. 1963 9 p refs
(TR-63-414-1)

The major contribution of the ion-metal film studies is to point up the necessity of performing space simulation radiation tests (including ultraviolet and extreme ultraviolet) in a contaminant-free environment. Materials degradation tests that were performed in chambers sealed with O-rings of Buna-N, Hycar, or blended natural rubber, and that have shown significant changes in surface optical properties should be confirmed by conducting correlating studies in a clean chamber. The extent of the ion-metal film contamination problem, as far as an actual spacecraft is concerned, is presently being studied. In addition, proposals were submitted to NASA to investigate the fundamental problem of optical degradation by irradiation of the components of decomposing polymers and the physics and chemistry of the discoloration mechanism. Author

N64-20890 Lockheed Missiles and Space Co., Sunnyvale, Calif.
MULTI-CHANNEL COLLISIONS
B. A. Lippmann Jan. 1964 53 p refs
(Contract Nonr-3368(00))
(Rept.-2-12-64-1; AD-439530)

The formal theory of scattering processes is extended to include multiple-channel scattering (rearrangement collisions). First, the single-channel case is reviewed. The multiple-channel case then is developed, in close analogy with the simpler case. The multiple-channel generalizations of the operator identities and the relations among the matrix elements that replace the familiar single-channel forms are derived. Time-reversibility, reciprocity, and unitarity are suitably defined for single-channel and multichannel collisions and are shown to have the property that any two implies the third. The generalization to particles with spin is discussed, and some remarks are made on the application to complex potentials (optical model), where time-reflection invariance implies only reciprocity. The theory of resonance scattering, in which the target and the incident particle can form a compound system of finite lifetime, is discussed. The roles of the electron-molecular interaction and the interaction resulting from the use of approximate (Born–Oppenheimer) molecular wave functions are considered. The manner in which these interactions enter into the relevant matrix elements is exhibited, and the derivation of a Breit–Wigner-type formula is carried out. In the course of the discussion, the general theory of the perturbation of a single discrete energy level embedded in a continuum is treated. Author

N64-20928 Joint Publications Research Service, Washington, D.C.
THE $2F_{5/2}$-$2F_{7/2}$ ABSORPTION SPECTRUM OF Ce^{3+} IN SILICA AND BORAX GLASS
Huang Hsi-huai and Pi Kaoho *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 37–41 refs Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 178–179 (See N64-20924 14-01) OTS: $3.00

The absorption spectrum of Ce^{3+} of several silica and borax glass specimens in the infrared region was studied using the Zeiss UR-10 type of infrared analysis. It was discovered that CeO_2 glass has an absorption peak at 3.5μ to 5.0μ. It is evident that Ce^{4+} under high-temperature melting will reduce to Ce^{3+}; it is retained in the glass sample. This type of absorption spectrum could determine the existence of Ce^{3+} in glass, and it could be used to study the "electrical" selective absorption of cerium glass and the property of CeO_2 in preventing the glasses from changing color under high radiation energy. I.v.L.

N64-21005 FIAT S.p.A., Turin (Italy) Nuclear Energy Sect.
A NEW APPROACH ON ENGINEERING HOT CHANNEL AND HOT SPOT STATISTICAL ANALYSIS
U. L. Businaro and G. P. Pozzi Brussels, EURATOM, Mar. 1964 49 p refs Presented at the Ann. Cong. of the Nucl. Soc., Pittsburgh, 17–19 Jun. 1963
(Contract EURATOM-035-60-11 RDi)
(EUR-1302.e; EURAEC-702) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 70 Belg. Fr.

To investigate the influence of fabrication tolerances on the thermal-hydraulic dependent variables in a reactor core, a core model was developed. This spot model considers each fuel channel to be divided into small regions; in these regions the independent variables subjected to statistical variations are assumed constant, and their actual values are chosen at random according to their experimental distribution curves. Having represented in this way an actual core, it is possible, with the aid of a detailed thermal and hydraulic calculation routine, to evaluate the dependent variables relative to such a core. This procedure is repeated according to a Monte Carlo technique, choosing at random as many random cores as necessary, making it possible to obtain the actual probability and distribution curves for the thermal-hydraulic dependent variables, and, by intersection with a certain confidence level, the relative expected values. This procedure programed as a Monte Carlo code (HYTHEST) on the IBM-7090 furnished the following results: (1) For nonlinearly dependent variables the most probable value is markedly shifted from the nominal value. (2) The channel type correction factors are generally smaller by an order of magnitude than that given by the conservative nonstatistical method. (3) The distribution curve and related moments depend on the assumed neutron flux shapes. Author

N64-21010 General Precision, Inc., Pleasantville, N.Y. GPL Div.
DETECTION OF FREQUENCY ERRORS IN A MAGNETIC RESONANCE OSCILLATOR, APPENDIX I
Ivan A. Greenwood *In its* Nucl. Gyroscope Study Apr. 1964 p 36–43 refs (See N64-21009 14-25)

This report describes a method for determining otherwise unknown, small phase-shift errors in an amplifier chain used for magnetic resonance observation. The method is described in terms of its application to the nuclear gyro problem, but may also be applied to other nuclear, atomic, electronic, and molecular resonance problems. One of the most critical problems in the design of a practical nuclear gyroscope is the error resulting from spurious phase shifts in the amplifiers used in the NMR feedback oscillators. This problem is described in detail. The method for detecting an amplifier phase shift is based on a given equation. It is proposed that the spin–spin relaxation time constant be modulated at a slow rate by modulation of field inhomogeneity, optical pumping rate, or equivalent means. If $\Delta\phi$ and

$\Delta\omega$ are zero, such modulation will produce no change in the frequency of the NMR feedback oscillator. If a nonzero $\Delta\omega$ is present, however, the oscillator frequency will be modulated in accordance with the equation, with the amplitude and sense of the frequency modulation being a measure of $\Delta\omega$ and hence of $\Delta\phi$. Author

N64-21014 Consolidated Vacuum Corp., Rochester, N.Y.
THE MEASUREMENT OF THE SPEED OF CRYOPUMPS
W. W. Stickney and B. B. Dayton 28 Aug. 1963 35 p refs

The cryopumping speed of a disk cooled to 10.2° K for nitrogen is measured by using a tubulated gage and a nude gage in a cylindrical test dome. A theoretical analysis of the system gives calculated sticking coefficients in the neighborhood of 1.00. Equations are presented for the effect of the length and diameter of the test dome on the gage readings. The equations predict and the data tend to confirm that the beaming effect of a test dome of diameter equal to that of the disk can result in maximum speeds for nitrogen as high as 29 liters-sec^{-1}-cm^{-2} with the nude gage and about 33 liters-sec^{-1}-cm^{-2} with a tubulated gage located adjacent to the cryosurface. Author

N64-21017 Oak Ridge National Lab., Tenn. Health Physics Div.
ELECTRON-SLOWING-DOWN SPECTRUM IN Cu OF BETA RAYS FROM Cu^{64}
W. J. Mc Connell, H. H. Hubbell, Jr., and R. D. Birkhoff May 1964 68 p refs
(Contract W-7405-ENG-26)
(ORNL-3463) OTS: $1.75

The Keplertron, a spherical, electrostatic focusing, beta spectrometer, was calibrated from 1 ev to 3 kev by using an electron gun that approximated a point source and at 31.4 kev by using the Sm^{152} KLL Auger line from a Eu-152 source of thickness 50μg/cm^2. The electron gun measurements agreed with the theoretical values of 6.3% for the energy resolution and 25% for the transmission. Deviations from theory at low energies were observed but were attributed to the energy spread of electrons from the electron gun. The electron flux spectrum resulting from the slowing down of electrons from Cu^{64} uniformly distributed in Cu was measured from 37 kev to 0.1 ev for both a plane disk source and a blackbody-cavity source by using the Keplertron. These measurements showed that the electron flux spectrum for the cavity corrected for instrumental response is in good agreement from 37 kev to 1 kev with the simplified Spencer–Fano theory. Author

N64-21022 Uppsala U. (Sweden)
BASIC CONCEPTS IN THE ELECTRONIC SPECTRA OF POLYATOMIC MOLECULES Technical Note No. 101
Sadhan Basu 1 Jun. 1963 46 p refs
(Contract AF 61(052)-351)
(ARL-63-2481; AD-600165)

This report deals with the following areas: (1) basic assumptions of the classical electron theory of optics—the classical oscillator model for electronic motion in the field of light waves and the experimental presentation of data in terms of oscillator strength and mean lifetime of the emission process; (2) a quantum mechanical description of the absorption and emission processes; (3) an analysis of the molecular absorption band; (4) the selection rule for spectral transition (selection rule for molecular electronic spectra and the electronic spectra of benzene); and (5) spin intercombination in molecules. I.v.L.

N64-21035 Columbia U., New York, N.Y. Radiological Research Lab.
ANNUAL REPORT ON RESEARCH PROJECT
H. H. Rossi 1 Jan. 1964 195 p refs
(Contract AT(30-1)-2740)
(NYO-2740-1) OTS: $2.75

Research in the following areas is discussed: (1) radiological physics, which includes (a) dosimetry of monoenergetic neutrons, (b) a tissue equivalent gas multiplication chamber, (c) dosimetry of 3-Gev protons, and (d) an ionization chamber for thermal neutron studies; (2) measurements of the microscopic distribution of radiation energy, which includes (a) monoenergetic neutron studies, (b) computer applications, and (c) tissue-equivalent proportional counters and gas-flow system; (3) radiation protection, which includes measurement of dose equivalent in mixed radiation fields; and (4) biophysics, which includes (a) relative biological effectiveness studies with monoenergetic neutrons, (b) radiation effects on cells in tissue culture, and (c) radiation effects on bacteria and bacterial viruses. Also discussed are: (1) a low-voltage X-ray generator; (2) long-term ionization-chamber stability; (3) the determination of the activity of an $yttrium^{90}$ solution; and (4) radiobiological research. I.v.L.

N64-21036 Pratt and Whitney Aircraft, Middletown, Conn.
THE INTEGRAL Be^9 (n, 2n) CROSS SECTION
F. F. Felber, Jr., D. R. Farmelo, and V. C. Van Sickle 19 May 1964 25 p refs
(Contract AT(30-1)-2789)
(PWAC-433) OTS: $0.75

The integral Be^9 (n, 2n) cross section was determined on beryllium and BeO specimens irradiated in the core of the Battelle Research Reactor. The value obtained was 460 ±60 millibarns, above 2.7 Mev in a fission spectrum. Fast neutron dosimetry was accomplished using iron, nickel, and titanium threshold detectors. The results are based on measurement of the total amount of helium produced during irradiation. Corrections were made for the small contribution from (n, α) reactions on Be^9 and O^{16}. Author

N64-21037 California U., Berkeley Lawrence Radiation Lab.
PROPERTIES OF THE ω MESON FROM $K^- + p \rightarrow \Lambda + \omega$
Joseph J. Murray, Jr., Massimiliand Ferro-Luzzi, Darrel O. Hune, Janice B. Shafer, Frank T. Solmitz et al 14 Mar. 1963 24 p refs
(Contract W-7405-ENG-48)
(UCRL-10723) OTS: $0.50

Studies of the reaction $K^- + p \rightarrow \Lambda + \omega$ at 1.51 Bev/c are reported. On the basis of 650 $\omega \rightarrow 3\pi$ decays and 40 $\omega \rightarrow$ neutral decays, the branching ratio of neutral to charged decay is found to be 0.11 ±0.03. The width of the $\omega \rightarrow 3\pi$ decay was determined to be 4 ±4 Mev by the use of an extrapolation method. Evidence for the rare two-pion decay mode is presented. The production angular distribution for the ω peaks slightly forward, as does that of the ρ meson. Cross sections for ω production and subsequent decay into its charged and neutral modes are 800 ±40 and 83 ±22μb, respectively. Author

N64-21038 Oak Ridge National Lab., Tenn.
X-RAY FLUORESCENCE TABLES: TOPAZ CRYSTAL
W. P. Amsbury, W. W. Lee, J. H. Rowan, and G. E. Walden 29 May 1964 118 p refs
(Contract W-7405-ENG-26)
(Y-1470-B) OTS: $2.25

Tables arranged by element, order, and line, and also angular tabulations for a specific analyzing crystal, were derived from a critical amalgamation of three standard reference tables of X-ray fluorescence lines. The format of these tables was

designed to increase the efficiency of the experimenter by decreasing the time spent in table searches. Both tables for a topaz crystal are included. Author

N64-21040 Kyoto U. (Japan) Research Inst. for Fundamental Physics
p-p PHASE SHIFTS AT 970 MeV
Yogiro Hama and Norio Hoshizaki Apr. 1964 60p refs
(RIFP-34)

In a previous paper, results of a phase-shift analysis of p-p differential cross section and polarization at 970 Mev, together with pion-production data at this level, were reported. By requiring that the real phase shifts be of Stapp No. 1 type, two solutions (A and B) corresponding to peripheral and nonperipheral absorption types were obtained. Recently, the p-p Coulomb-interference effects were measured at this energy and found to be slightly destructive. Since these effects can supply additional information for the determination of phase shifts, an investigation was conducted to acertain whether these interference data could make a choice between the two solutions previously obtained. The analysis was carried out by starting from solutions A and B, and allowing the parameters to vary in the same phase-shift space as in I. Results showed that the interference data slightly favor solution A over B. However, triple scattering measurements would be required to make a choice between the two solutions. Also, the curve of differential cross section in the angular region 3° ~ 12.5° for solution A and B is almost identical. I.v.L.

N64-21070 General Electric Co., Syracuse, N.Y. Heavy Military Electronics Dept.
PASSIVE OPTICAL TECHNIQUES INVESTIGATION Final Report
A. D. French, O. R. Bakeman et al Griffiss AFB, N.Y., RADC, Jan. 1964 393 p
(Contract AF 30(602)-2886)
(RADC-TDR-63-415; AD-600545)

The parameters and trades involved when using various passive optical techniques to separate earth orbiting objects from the celestial background and the capability of orbit prediction from angle-only data are presented. In addition, brief discussions of the celestial background, atmospheric effects, target brightness factors, lens (optical) design, detection theory, and sensor capabilities are reported in modified handbook form. Author

N64-21080 Naval Radiological Defense Lab., San Francisco, Calif.
FLASH VAPORIZATION OF SOLID MATERIALS FOR MASS SPECTROMETRY BY INTENSE THERMAL RADIATION
K. A. Lincoln 24 Mar. 1964 12 p refs
(Contract DASA-MIPR-526-64)
(USNRDL-TR-736; DASA-1468; AD-600159)

Mass spectra of low-vapor pressure materials, such as polymers and metals, are obtained by the technique of flash-vaporization mass spectrometry. Single, thermal pulses from a xenon flashtube vaporize the samples directly into the ion source of a time-of-flight mass spectrometer; the mass spectra appear momentarily on the screen of an oscilloscope and are recorded photographically. This technique, which also renders some short-lived species amenable to mass spectrometric studies, and the apparatus, including vacuum lock for introducing solid samples into the instrument, are described. Author

N64-21089 Naval Ordnance Lab., White Oak, Md.
A PROPOSAL FOR THE STUDY OF COLLISIONAL PROCESSES LEADING TO ELECTRONIC EXCITATION AND IONIZATION BEHIND SHOCKWAVES Ballistics Research Report 93
Ernst H. Winkler Sep. 1963 16 p refs
(NOLTR-63-33; AD-415369)

It is proposed to utilize alkali metal vapors to study the fundamental collisional processes leading to ionization and electronic excitation in gases behind strong shockwaves. The advantages that result from the substitution of alkali metal vapors for ordinary gases are presented, and a suitable arc-heated test facility is described. Author

N64-21099 Harry Diamond Labs., Washington, D.C.
THE TATARSKIAN CORRELATION FUNCTION FOR ARBITRARY TURBULENCE CONDITIONS
W. J. Brinks 25 Mar. 1964 18 p refs
(TR-1209; AD-600443)

In Tatarski's theory of wave propagation through a turbulent medium, a certain intractable integral was evaluated numerically. This allows the computation of the cross correlation of the logarithmic amplitude fluctuations at two spaced receivers, for any arbitrary turbulence distribution along the propagation path. The question of obtaining the turbulence distribution from a known cross-correlation function is also treated. Author

N64-21149 General Electric Co., Philadelphia, Pa. Space Sciences Lab.
ROTATIONAL EXCITATION OF MOLECULAR IONS BY ELECTRONS Technical Report No.2
D. H. Sampson May 1964 31 p refs
(Contract Nonr-4188(00))
(R64SD31; AD-600430)

The first-order perturbation theory used by R. C. Stabler to compute the cross section for rotational excitation of homonuclear diatomic molecular ions by electrons is shown to be equivalent to an approximation of the distorted wave method for which the validity criteria can be specified with more precision. It appears to be valid to express the interaction energy by the form $V(\bar{r}) = V_0(r) + V_2(r)\, P_2(\bar{r} \cdot \bar{s})$; however, use of the long range forms for $V_0(r)$ and $V_2(\bar{r})$ for all r is not valid. Moreover, for $r > r_0$, where r_0 is the approximate radius of the molecular charge cloud, $V_2(r)$ should include the r^{-4} induced dipole interaction that usually gives a contribution only a little less significant than that due to the quadrupole interaction treated by Stabler. Author

N64-21160 RAND Corp., Santa Monica, Calif.
COMPUTATION OF THE MATRIX ELEMENTS OF QUANTUM MECHANICS
Glenn H. Peebles Nov. 1963 42 p refs
(Contracts AT(40-3)-414; AF 49(638)-700; Proj. RAND)
(RM-3826-PR/AEC; AD-425953)

This memorandum develops numerical methods for each of the three calculations into which the computation of a matrix element separates. These three calculations are: the generation of two wave functions, such as, $u_1(x)$ and $u_2(x)$; the computation of the normalization factor for the two wave functions; and the calculation of the integral

$$\int_0^\infty u_1(x) \cdot m(x) \cdot u_2(x)dx,$$

the operator m(x) being given. Computation speed is gained by arranging the calculation in such a way that each wave function and each matrix element is advanced on the same

interval before going on to the next interval; the larger the ratio of the number of matrix elements to the number of wave functions, the more effective is this device. Author

N64-21164 Brown U., Providence, R.I. Div. of Applied Mathematics

A NOTE ON THE ONSET OF CONVECTION IN A SELF-GRAVITATING SPHERE Technical Report No. 53

P. P. Niiler and F. E. Bisshopp Apr. 1964 9 p refs

(Contract Nonr-562(07))

(Rept. 562(07)/53; AD-439525)

The equation governing motion and internal energy balance in a self-gravitating spherical liquid mass, containing a uniform distribution of internal heat source, permits a steady solution, where the fluid is at rest and the spherically symmetric temperature field decreases outward from the center of the sphere. If the coefficient of volume expansion of the liquid is positive, then, due to gravitational acceleration, the hotter liquid in the center of the sphere will possess excess buoyancy with respect to the cooler liquid at the surface and will tend to rise. The viscous frictional forces will inhibit the liquid from rising, and, consequently, a finite, critical rate of internal heating is necessary to produce such motion. An analogous situation is present in the onset of convective instability in the Benard problem, in which a stationary horizontal layer of liquid, acted upon by gravity, is heated from below. An asymptotic treatment of the exact solution of the problem for a self-gravitating sphere is considered. Reference is made to Chandrasekhar's formulation of the equations governing marginal stability of axisymmetric velocity and temperature perturbations. R.T.K.

N64-21183 Brown U., Providence, R.I. Div. of Applied Mathematics

A CORRESPONDENCE PRINCIPLE FOR VISCOELASTIC WAVE PROPAGATION

I. Herrera (Mexico U.) and M. E. Gurtin Feb. 1964 9 p refs

(Contract Nonr-562(25))

(TR-25; AD-436823)

A correspondence principle appropriate to the linearized theory of wave propagation through anisotropic and inhomogeneous viscoelastic solids is proved. This principle may be stated roughly as follows: The speed of propagation of an acceleration wave through a viscoelastic solid of density $\rho(x)$ and relaxation tensor $G_{ijkl}(x,t)$ is identical to the speed of propagation of the same wave through an elastic solid of density $\rho(x)$ and elasticity tensor $c_{ijkl}(x) = G_{ijkl}(x,0)$. Author

N64-21193 European Atomic Energy Community, Brussels (Belgium)

HYTHEST – A MONTE CARLO PROGRAM FOR THE EVALUATION OF THE CORRECTION FACTORS IN A BWR AND PWR CORE

A. Borella, G. Di Cola, and G. Pozzi (Fiat) Joint Nucl. Res. Center, Ispra Estab. (Italy) Mar. 1964 75 p refs

(Contract EURATOM-035-60-11-RDI)

(EURAEC-987; EUR 1587.e) Available from the Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 125 Belg. Fr.

HYTHEST is a Monte Carlo code written in FORTRAN language for the IBM-7090. With this code, it is possible to study statistically the influence that the random variations of the independent parameters subjected to fabrication tolerances (fuel density and enrichment, geometric dimension) have on the dependent thermal hydraulic variables (temperatures, vapor quality, pressure drop) in a PWR and BWR reactor core. According to the spot model, a random core is built up, choosing in every region of the core the values of the independent parameters with the aid of a random sampling routine. Next, with a detailed thermal hydraulic calculation routine, the values of the dependent variables are calculated in this random sampled core. This procedure is repeated according to a Monte Carlo technique, choosing as many random cores as necessary. Author

N64-21208 European Atomic Energy Community, Brussels (Belgium)

THE MAGNETIC MIRROR NEUTRON POLARIZER AT THE REACTOR "ISPRA I"

M. Forte Joint Nuclear Research Center, Ispra Estab. (Italy) Reactor Phys. Dept., Mar. 1964 18 p refs Presented at the Intern. Conf. on Nucl. Phys. with Reactor Neutrons, Argonne, Ill., 15–17 Oct. 1963

(EUR-538.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

A polarized neutron beam was produced at the reactor Ispra 1 by the method of total reflection of slow neutrons on a magnetized mirror of Co + 6% Fe alloy. The mirror is composed of 10 optically aligned segments, with a total length of 110 cm, and is placed in a magnetic gap where the field intensity is ~ 300 gauss. Intending to use the polarized neutron beam for capture-gamma-ray experiments, a convenient compromise of the operating conditions was chosen. The measured polarization was then ~ 80% and the intensity ~ 3.10^7 n/sec over a beam cross section of 8 cm height and few mm width. Careful beam collimation and shielding permit a reasonably low-fast neutron and gamma-ray background (a gamma dose of ~ 50 mr/hr in the beam). The spin of neutrons, guided in a special magnetic box where the field is gradually turned at 90°, can be reversed at the target position by reversing the box magnetizing current. With moderate magnetic shielding, the reversal of the box field produced no systematic variation larger than 10^{-5} in the gain of conventional-type scintillation counters placed close to the target. The paper includes a description of the whole apparatus and some details of the mirror fabrication and mounting, as well as measuring instrumentation and methods. Author

N64-21209 European Atomic Energy Community, Brussels (Belgium)

ANALYSIS AND DEVELOPMENT OF THE SERIES EXPANSION METHODS IN THRESHOLD DETECTOR ACTIVATION DATA HANDLING

G. Di Cola and A. Rota Joint Nuclear Res. Center, Ispra Estab. (Italy) Sci. Data Process. Center, Feb. 1964 19 p refs Presented at the Symp. on Fast and Epithermal Neutron Spectra in Reactors, Harwell, Gt. Brit., 11–13 Dec. 1963

(EUR-588.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

The threshold detector activation data treatment by the series expansion methods has been analyzed. The numerical problems connected with the use of digital computers have been investigated. A development connected with the possibility of using detectors with quasi-linear dependent cross sections is proposed. The series expansion coefficients were obtained through the gauss method by solving a least-square problem. Experimental and test activation data have been processed. Author

N64-21218 Atlantic Research Corp., Washington, D.C. Jansky and Bailey Div.

SPECTRUM SIGNATURE MEASUREMENTS ON AIR ROUTE SURVEILLANCE RADAR (ARSR-1B-A) AT POINT ARGUELLO, CALIFORNIA

James J. Crenca, Carl P. Mc Call, James T. Luck, James D. Powers, Harry Zinc (Frederick Res. Corp.) et al Mar. 1963 202 p
(Contract AF 30(602)-2537)
(RADC-TDR-63-363; AD-431880)

This report describes the spectrum signature measurements made on an Air Route Surveillance Radar (ARSR-1B-A). Description of the tests and results of the measurements are given for the ARSR-1B-A transmitter. Author

N64-21239 California Inst. of Tech., Pasadena. Antenna Lab.
THEORY OF THE SCATTERING OF ELECTROMAGNETIC WAVES BY IRREGULAR INTERFACES Technical Report No. 30
Kenneth M. Mitzner Jan. 1964 131 p refs
(Contract AF 49(638)-1266)
(AFOSR-64-0802; AD-436811)

Reflection of a partially polarized plane wave from a plane interface with large irregularities was studied using geometrical optics. Matrix transformations relating incident and reflected waves were obtained for reflection from a single specular point and from an extended area containing many independent reflectors. The properties of a wave reflected from a diffusely illuminated rough interface were found. The method of small perturbations was used to study scattering of an arbitrary, completely polarized wave from an irregular interface of general underlying shape. The irregularities were replaced by equivalent surface currents, and the field in space was found using the dyadic Green's functions of the unperturbed problem. The results obtained are valid when the irregularity has small slope and amplitude small compared to the wavelength and local radii of curvature. The facilitate applications, the theory of dyadic Green's functions was developed, and the necessary functions were evaluated for simple geometries. Author

N64-21249 General Electric Co., Philadelphia, Pa. Space Sciences Lab.
PHOTO-IONIZATION CONTINUA. I. THE BOUND FREE CONTINUA OF NEGATIVE IONS
R. G. Breene, Jr. Apr. 1964 17 p refs
(R64SD28)

The photoionization, or bound-free continuum, of the negative oxygen ion is considered. The effects of correlation in the bound function and the form of the operator on a treatment of the phenomenon are directly demonstrated, and the effect of polarization in the free function is pointed out. For the representations the operator used, the asymptotic form of the free function is essentially equivalent to the precise form. An ab initio calculation for the cross section yields results some 30% greater than experiment and of the proper form. Author

N64-21266* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THEORY OF THE 2s AND 2p EXCITATION OF THE HYDROGEN ATOM INDUCED BY ELECTRON IMPACT
Kazem Omidvar Washington, NASA, Jun. 1964 50 p refs Submitted for Publication
(NASA-TN-D-2145) OTS: $1.50

The method of partial waves is used to calculate the excitation cross section of the ground state of the hydrogen atom to the 2s and 2p levels induced by electron impact. The exchange integrals that appear in the differential equations for the excitation process necessitate the solution of these differential equations to be carried out by an iterative method. In this paper a noniterative method is used to solve these differential equations. As a result, accurate values are obtained for the cross sections corresponding to the 2s and the 2p excitations. Specifically the 1s→2s cross section above threshold shows an interesting structure with certain maxima and minima that may be the subject of verification by experiment. Author

N64-21277* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio
ANOMALOUS BEHAVIOR OF THE COULOMB *T* MATRIX
William F. Ford Repr. from Phys. Rev., v. 133, no. 6B, 23 Mar. 1964 p B1616–B1621 refs
(NASA-RP-178)

Some apparent discrepancies in the definition or calculation of the Coulomb *T* matrix are investigated in an approach that uses shielded wave functions. The screened Coulomb *T* matrix behaved anomalously in the neighborhood of the energy shell and was in fact discontinuous in the limit of zero screening. A closed-form expression for the *T* matrix, derived previously, was shown to be essentially correct off the energy shell. Author

N64-21290 Union Carbide Corp., Tonawanda, N.Y. Linde Div.
THE CRYOSORPTION PUMPING OF HYDROGEN AT 20° K
R. A. Hemstreet, Q. G. Robb, J. R. Pitlor, L. D. Potts, D. M. Ruttenbur et al Arnold Eng. Develop. Center, May 1964 66 p refs
(Contract AF 40(600)-944)
(AEDC-TDR-64-100; AD-439850)

An experimental and theoretical study of the pumping of hydrogen by adsorbents cooled to 20°K is presented. The study covers the pressure range of 10^{-9} to 10^{-5} torr. The adsorbents studied were charcoal, molecular sieves 4A, 5A, 10X, 13X, and several special molecular sieves containing aluminum flake. Molecular sieve 5A was selected as the preferred adsorbent for hydrogen cryosorption pumping. Incorporation of aluminum flake into the molecular sieve increased its thermal conductivity and reduced its optical emissivity. Techniques were developed for bonding molecular sieves to metal surfaces to form cryosorption panels. A hydrogen adsorption coefficient of 0.16 was measured for a molecular sieve 5A surface to aluminum. An economic analysis of hydrogen cryosorption pumping indicated that for large space chamber applications, the capital and operating costs of cryosorption pumping are about one order of magnitude cheaper than for conventional diffusion pumps. Author

N64-21309 Stanford Research Inst., Menlo Park, Calif.
GRAPHICAL DATA PROCESSING RESEARCH STUDY AND EXPERIMENTAL INVESTIGATION Quarterly Progress Report 2
A. E. Brain and S. W. Miller Jan. 1964 31 p
(Contract DA-36-039-AMC-03247(G))
(Rept.-14; AD-600331)

Modifications were made to the design of the 1000-image preprocessor to improve the signal-to-noise ratio where this was marginal, and to provide better integration of the light transmitted by the masks. The study of the interface problem between the Burroughs B-5000 and MINOS II infers that cooperation between the two machines on a time-sharing basis is practical. The ramp generators used in the weight-changing algorithm and in the 100-image preprocessor are discussed in detail. Author

N64-21340 Bolt, Bernanek, and Newman, Inc., Cambridge, Mass.
VORTEX-SHEDDING SOUNDS OF PROPELLERS

Donald Ross 16 Mar. 1964 65 p refs
(Contract NObs-86680, Phase II)
(Rept.-1115; AD-435765)

Equations developed by Phillips and by Etkin, Korbacher, and Keefe for the sound intensity associated with vortex shedding, are simplified through the use of hydrodynamical relationships between the Strouhal number, the oscillating lift, and the drag coefficient. Besides the Mach number, the only factor influencing the efficiency of conversion of hydromechanical power into acoustical power was the spanwise coherency of the vortex shedding. For a rigid body, this coherent length is only about three times the transverse vortex spacing, whereas when a body vibrates, it will tend to be almost as long as the body itself. This effect plays a dominant role in the phenomenon of propeller "singing." The report includes a literature review of about 110 articles on various aspects of vortex shedding as well as a bibliography of some 130 items. Author

N64-21344 Laboratoire de Physique Theorique et Des Hautes Energies, Orsay (France)
POLARIZATION OF Λ HYPERONS FROM $\gamma + p \rightarrow K^+ + \Lambda$ REACTION
Jean Dufour Apr. 1964 27 p refs

A phenomenological model is applied to the reaction $\gamma + p \rightarrow K^+ + \Lambda$, to account for the results of experiments about this process. In addition to functions of Born and of K^*, one retains the third π–N resonance (F 5/2, 1/2), which gives a polarization of Λ in good accord with the experiment. Several groups of parameters are proposed that agree well and correspond with different values of magnetic moment of Λ. The results obtained are discussed briefly and are compared to those predicted by the analogous models. Transl. by D.E.W.

N64-21367 Sperry Microwave Electronics Co., Clearwater, Fla.
INVESTIGATION OF LARGE SIGNAL MICROWAVE EFFECTS IN FERROELECTRIC MATERIALS Quarterly Report No. 2, 1 Oct.-31 Dec. 1963
G. A. Burdick and T. J. Lyon Jan. 1964 49 p ref
(Contract DA-36-039-AMC-03240(E))
(SJ-230-0048-2; AD-433206)

Experimental results of measurements made on selected ferroelectrics are reported, including (1) insertion loss and phase shift as a function of sample thickness at 35 Gc; (2) dielectric constant as a function of temperature measured at 1 kc; (3) transmission as a function of frequency from 26.5 Gc to 40 Gc; and (4) response to d.c. biasing fields at 35 Gc. For these measurements, four compositions of barium-strontium titanate ceramic were selected along with single crystal samples of tri-glycine sulfate. A diaphragm test holder was used with a microwave bridge circuit in accumulating insertion loss and phase shift data for the calculation of dielectric constant and loss tangent. Calculated values were cross-correlated by independent methods of data reduction. Sets of qualitative characteristics of dielectric constant at 1 kc as a function of temperature were obtained using an RC circuit and an enclosed environmental chamber. Curves recorded to this point show qualitative correlation with data taken at 35 Gc. Plots of insertion loss versus frequency were obtained for single crystal TGS samples. The microwave signal was continuously swept from 26.5 Gc to 40 Gc. Author

N64-21368 Aerospace Corp., El Segundo, Calif. Space Physics Lab.
ISOTOPIC ABUNDANCE OF VERY HIGH ENERGY PARTICLES [Semi-annual Report] 1 Jul.-31 Dec. 1963
P. A. M. Gram 25 May 1964 9 p refs
(ATN-64-(9234)-2)

Improvements in the experimental technique for measuring isotopically resolved energy spectra of high-energy particles (hydrogen and helium isotopes) in space are presented. To reduce the effects of Landau straggling upon the determination of dE/dx, four counters instead of one are used. The pulse height information from each of the four counters is telemetered separately. The logic that determines the range of the detected particles has been greatly simplified by using a delay line mixer and a simple counter to encode the range information. Fast, charge-sensitive amplifiers have been developed that enhance the signal-to-noise ratio with which the energy deposited in a solid-state detector can be measured. Author

N64-21378 Oklahoma City U., Okla.
THE FIRST PICOSECOND IN AN EXPLODING WIRE
Moody L. Coffman [1961] 17 p refs

A theory of exploding wires is presented. It is assumed that the abrupt application of an electric field to a wire leads to initial motion of the free electrons while the atom structure remains fixed. Then atoms oscillate in the resulting field. A mechanism is given by which standing waves are established, and these give rise to variable amplitudes of oscillation of atoms within the structure. As the amplitude of vibration of atoms is then a function of position along the wire, the temperature of the wire is also a function of position. Therefore, the thermionic emission rate varies with position, and the charge density varies with position along the wire. It is proposed that coulomb repulsion aids thermodynamic change of phase to control the trajectory of the particles from the exploding wire. Author

N64-21413 ARO, Inc., Arnold Air Force Station, Tenn.
SPECIFIC HEAT AND SPEED OF SOUND DATA FOR IMPERFECT AIR
Clark H. Lewis and Charles A. Neel Arnold Eng. Develop. Center, May 1964 157 p refs
(Contract AF 40(600)-1000)
(AEDC-TDR-64-36; AD-600469)

Specific heat and speed of sound data were computed for imperfect air. The thermodynamic data included the effects of two-body intermolecular forces, and the results were obtained by numerical interpolation and differentiation of the recent data of Hilsenrath and Klein. Comparisons with previous perfect gas calculations showed small effects in the isentropic exponent γ_E and dimensionless speed of sound a/a_a below one amagat and negligible effects on the specific heat data for all densities up to $\log \rho = 2.2$. Author

N64-21444 North American Aviation, Inc., Columbus, Ohio
INVESTIGATION OF SIMULATION OF SHOCK-SHOCK INTERACTION IN HYPERSONIC GASDYNAMIC TEST FACILITY
Gene J. Bingham and Theodore E. Davidson Wright-Patterson AFB, Ohio, Flight Dyn. Lab., Mar. 1964 63 p refs
(Contract AF 33(657)-10786)
(FDL-TDR-64-9; AD-435813)

An experimental investigation is conducted to determine the feasibility of laboratory simulation of the interaction of the shock wave of a hypersonic body with a separate moving shock wave. The experimental technique uses a blunted cone mounted in a hypersonic wind tunnel to generate the body shock wave. Shock tubes are used to generate the moving shock wave. The hypersonic tunnel is operated at Mach 7.3. The shock tube generates moving shock wave velocities from 3,600 to 13,500 fpsec. The tubes are installed at angles of 30°, 60°, 90°, and 120° with respect to the tunnel centerline. Schlieren photographs

show that the moving shock wave will move across the hypersonic stream and intersect the body. Transient pressures associated with arrival of the moving shock wave increase with increasing shock velocity. Author

N64-21449 Harvard U., Cambridge, Mass. Cruft Lab.
SPIN WAVE INSTABILITIES IN PERMALLOY FILMS OF VARYING THICKNESS Scientific Report No. 8
J. B. Comly and T. Penney 17 Dec. 1963 64 p refs
(Contract AF 19(604)-5487)
(AFCRL-64-101; AD-440281)

High-power spin-wave instabilities with the microwave field perpendicular to the d.c. field have been observed in 83:17 Permalloy films. Measurements have been made of X'' vs H for various power levels and X'' vs h_{rf} at resonance. Data are presented for 14 samples ranging in thickness from 75 A to 7400 A. The results indicate that the usual spin-wave spectrum is progressively distorted as the film thickness decreases. Author

N64-21474 Melabs, Palo Alto, Calif.
INVESTIGATION OF MICROWAVE NON-LINEAR EFFECTS UTILIZING FERROMAGNETIC MATERIALS Seventh Quarterly Progress Report, Aug. 17-Nov. 16, 1963
Lee F. Donaghey [1963] 20 p
(Contract DA-36-039-SC-89206)
(AD-433873)

The general solution is given for the equation of motion for the magnetization of a ferrite sample under parallel pumping, and orthogonal cavity detuning and signal magnetic field orientation. Normal mode solutions are obtained when the driving fields are assumed to be circularly polarized. A zeroth order solution is developed when the detuning fields are included in the effective RF driving field. An experimental cavity for which the above analysis applies was developed to allow loop coupling to a ferrite disc. Pump stabilization and magnetic bias field strength calibration are discussed. Author

N64-21484 Oak Ridge National Lab., Tenn.
PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1964
J. L. Fowler Jun. 1964 172 p refs
(Contract W-7405-ENG-26)
(ORNL-3582) OTS: $2.75

Abstracts for papers that have been published or that have been prepared for publication are presented, along with preliminary results of work presently in progress. P.V.E.

24 PHYSICS, PLASMA

Includes fusion; and magnetohydrodynamics. *For related information see*: 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N64-20759 Philipps-Universität, Marburg (W. Germany) Physikalisches Inst.
WAVE PROPAGATION IN A PLASMA
Kurt Suchy *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 89–117 refs (See N64-20752 14-12) Pergamon Press: 80 s.

The conductivity tensor for a plasma in a magnetic field is deduced statistically for transverse plasma waves with frequencies above the gyrofrequency of the ions. The vector wave equation is transformed into a pair of coupled wave equations governing the propagation of the two "characteristic polarizations" originating from the birefringence of the plasma in a magnetic field. Coupling and reflection of these two characteristic polarizations are discussed on a two-sheet Riemann surface for a complex quantity ζ containing the plasma parameters and the wave frequency. A general law of refraction (in vector form) is given and specialized for stratified media. Author

N64-20760 Naples U. (Italy) Space Physics Study Center
WAVES IN A MAGNETO-HYDRODYNAMIC MEAN
Luigi G. Napolitano *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 119–135 refs (See N64-20752 14-12) Pergamon Press: 80 s.

The interaction and the coupling of electromagnetic and hydrodynamic fields in a medium steeped in a uniform magnetic field are investigated. Fundamental equations are given, and it is demonstrated that only an accurate and proper setting of the problem can lead to the establishment of more general expressions for heat flows and electric charges than have been derived heretofore. I.v.L.

N64-20817* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
TEMPERATURE EFFECT ON LANGMUIR PROBE MEASUREMENT
Che Jen Chem Oct. 1963 20 p refs
(Contract NAS7-100)
(NASA CR-56170; JPL-TM-33-157) OTS: $1.60 ph

When a moderately heated tungsten Langmuir probe was immersed in an argon plasma in a discharge tube, a substantial lowering of its work function was observed. The mechanism is thought to be similar to the Schottky effect. The influence of this phenomenon on the accuracy of the probe measurements is discussed. Author

N64-20824 Aerospace Corp., El Segundo, Calif. Plasma Research Lab.
GENERAL RESEARCH ON THE CURVATURE AND TORSION OF AN ISOLATED VORTEX FILAMENT
Robert Betchov 15 May 1964 21 p refs
(ATN-64(9231)-4)

A very thin vortex filament in an unbounded, incompressible and inviscous fluid was considered. The filament is not necessarily plane. Each portion of the filament moves with a velocity that can be approximated in terms of the local curvature of the filament. This approximation leads to a pair of intrinsic equations giving the curvature and the torsion of the filament, as functions of the time and the arc length along the filament. Helicoidal vortex filaments are elementary solutions and are unstable. The intrinsic equations also suggest a linear mechanism that tends to produce concentrated torsion and a nonlinear mechanism tending to disperse such singularities. Author

N64-20860 Illinois U., Urbana Gaseous Electronics Lab
ELECTRON INTERACTIONS IN CRYOGENIC HELIUM PLASMAS Scientific Report No. 1
P. D. Goldan, J. H. Cahn, and L. Goldstein Dec. 1963 139 p refs
(Contract AF 19(629)-3307)
(AFCRL-64-67; AD-600045)

The results of an experimental investigation of electron interaction in a gaseous plasma, by the use of swarm techniques, for electron-gas temperatures as low as 5° K are reported. Microwave studies of the helium plasma afterglow

were undertaken under cryogenic conditions. A basic theory of microwave measurement techniques was developed, and an attempt was made: (1) to correlate measured collisional rates, for both momentum and energy transfer, with theoretical expectations based on measurements made at higher electron energies; and (2) to demonstrate the inapplicability of binary collision theory to the energy region under consideration. The following are also discussed: (1) electron heating during the plasma afterglow, presumably through the mechanism of superelastic collisions; (2) sound-wave modulation of plasma microwave propagation characteristics; and (3) anomalous light quenching and its implications with regard to electron–ion recombination rates. R.T.K.

N64-21012 California U., Livermore Lawrence Radiation Lab.
FEASIBILITY CONSIDERATIONS IN THE APPLICATION OF LASER DIAGNOSTICS TO PLASMAS OF DENSITY $\sim 10^{13}$ cm^{-3}
Robert E. Ellis and Frederick R. Kovar 16 Mar. 1964 28 p refs
(Contract W-7405-ENG-48)
(UCRL-7712) OTS: $0.75

The feasibility of the use of a pulsed ruby laser system for the purpose of determining plasma electron temperature and density is examined, assuming an electron density of $\sim 10^{13}$ cm^{-3} and an electron temperature of ~ 100 ev. The signal, to be obtained by detecting a portion of the Doppler-broadened spectral distribution of laser radiation scattered at 90° to the incident beam, is calculated. Effects of plasma bremsstrahlung, stray light from the primary laser beam, and light from excited, partially ionized atoms are estimated. It is pointed out that, in principle, the unpolarized light from the plasma may be discriminated against by splitting the light entering the viewing system into two mutually perpendicular, polarized components, which are then to be detected separately and nulled out in a differential amplifier. A brief consideration of the use of laser interferometry for the determination of plasma electron density is included. Author

N64-21028 North Carolina State Coll., Raleigh
MAGNETO-PLASMADYNAMIC CHANNEL FLOW WITH HALL CURRENTS
James T. Yen and Charles L. Farn Wright-Patterson AFB, Ohio, Aerospace Res. Labs., Aug. 1963 49 p refs
(Contract AF 33(657)-8068)
(ARL-63-145; AD-421497)

Magnetoplasmadynamic channel flow with Hall currents was considered by using real parameters W, N_1, and N_2, defined in this report. The solutions obtained were a new type, different from the usual Hartmann-type solutions; several conclusions were deduced. The solutions obtained can be shown as equivalent to those of Sherman and Sutton when $\epsilon_1 = \epsilon_3 = 1$ (ϵ_1, ϵ_3 are defined in this report). Both papers employ real parameters and are written independently. Introducing complex parameters, Yen succeeded in greatly simplifying and extending the above solutions to cover various cases of energy conversion. Three new functions were found by Yen, and are tabulated. Author

N64-21072 Space Sciences, Inc., Waltham, Mass.
NANOSECOND PULSE BREAKDOWN IN GASES Final Report
P. Felsenthal and J. M. Proud Griffiss AFB, N.Y. RADC, Mar. 1964 33 p refs
(Contract AF 30(602)-2779)
(RADC-TDR-64-38; AD-600650)

It is shown analytically that under certain conditions pulsed d.c. and pulsed microwave breakdown are directly comparable. A pulsed d.c. experimental system to measure breakdown over a wide range of applied voltage, gas pressure, and gap distance has been used to measure formative time in air, helium, and nitrogen. The results, when compared with the theoretical predictions of breakdown, confirm the utility of the theory in describing breakdown within the imposed limits. The accuracy and extent of the present measurements materially extend the present range of pulsed microwave breakdown data. Author

N64-21087 Michigan U., Ann Arbor Radiation Lab.
A STUDY OF PLASMA APPLICATIONS IN MICROWAVE CIRCUITS Final Report
A. Olte and E. K. Miller Jan. 1963 107 p refs
(Contract AF 30(602)-2605)
(Rept. 4915-1-F; RADC-TDR-63-54; AD-409596)

The RF properties of a coaxial transmission line with a slotted outer conductor that passed through a cylindrical glow discharge were examined. The transmission characteristics were examined for a plasma column length of 30.5 cm for frequencies between 500 to 4200 Mc. Argon, helium, and nitrogen gas were used at pressures between 0.02 mm Hg and 2 mm Hg. The results are compared with theory by using a Lorentzian model to describe the electron motion in the RF field. A graphical technique for finding the electron density and electron momentum transfer collision frequency is discussed, and the results are compared with Langmuir probe measurements. The second configuration consisted of a plasma slab placed across one side of a square waveguide with its broad side parallel to the waveguide wall. A static magnetic field is applied normal to the waveguide axis and parallel to the slab. Interaction of a TM_{11} mode with the magnetoplasma was examined as a function of the plasma frequency, magnetic field strength, and microwave frequency. Author

N64-21114 Comitato Nazionale per l'Energia Nucleare, Frascati (Italy) Laboratorio Gas Ionizzati
EXPERIMENTS ON SPACE CHARGE SHEATHS [ESPERIENZE SULLE GUAINE DI CARICA SPAZIALE]
France Magistrelli Brussels, Euratom, Mar. 1964 13 p refs In ITALIAN; ENGLISH summary Presented at the Cong. on Some Aspects of Plasma Physics, Milan, 6–7 May, 1963
(Contract EURATOM-009-62-7 FUAI)
(EUR-495.I) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

The experiment reported is on the sheath formation in the presence of a weak azimuthal magnetic field. This experiment led to another one regarding the current limitation in a low-pressure mercury arc, and to a study of the stationary pinch. Reference is also made to preliminary work carried out on ionic waves; these will be studied in low-pressure mercury arcs and in cesium plasmas in thermodynamic equilibrium. The apparatus for the experiments is under construction and will be used not only for the study of ion waves but also for a general study of a plasma in equilibrium. Other experiments are briefly described that deal with the unipolar arc, radiofrequency plasmoids, and a method for obtaining a high d.c. current in gases other than mercury vapor. Author

N64-21145 Lincoln Lab., Mass. Inst. of Tech., Lexington
THE MEASUREMENT OF ELECTRON DENSITY IN THE WAKE OF A HYPERVELOCITY PELLET OVER A SIX-MAGNITUDE RANGE
M. Labitt 15 Apr. 1963 12 p refs
(Contract AF 19(628)-500; ARPA Order 13)
(TR-307; AD-407965)

A UHF cavity probe has been used to determine the line densities and collision frequencies of electrons deposited in the wakes of spherical aluminum pellets. Density data were obtained over a wide dynamic range of up to six orders of magnitude. These density curves are characterized by a sudden drop of about three or more orders of magnitude, which occurs when the wake has cooled to a critical temperature that is a function of pressure. The sudden drop is attributed to the oxygen-molecule attachment-detachment equilibria, whereas the final leveling portion of the wake is regulated by the positive-to-negative-ion recombination rate. The collision frequencies throughout the entire density range are in agreement with those obtained through mobility studies. Author

N64-21155 General Electric Co., Philadelphia, Pa. Space Sciences Lab.
NON-EQUILIBRIUM IONIZATION AND MAGNETOHYDRODYNAMIC PHENOMENA
Arthur Sherman (Ph.D. Thesis—Pa. U.) May 1964 128 p refs
(Contract AF 49(638)-914)
(R64SD36; AD-600526)

The author demonstrates that the nonequilibrium phenomenon can be incorporated into a single fluid theory sufficiently simple so that magnetohydrodynamic flow problems can be treated and some simple solutions obtained. Only the Hartmann flow is actually discussed in the paper. The rationalized μ kcs system of units is used. There are four chapters: (1) "Non-Equilibrium Ionization in Stationary Plasmas"; (2) "Phenomena in a Moving Plasma in the Presence of an Applied Magnetic Field"; (3) "Theoretical Analysis of Channel Flow"; and (4) "Discussion and Summary." A.W.

N64-21167 General Dynamics/Astronautics, San Diego, Calif. Space Science Lab.
EQUILIBRIUM COMPOSITIONS, THERMODYNAMIC AND NORMAL SHOCK PROPERTIES OF AIR WITH ADDITIVES, VOLUME 2
O. R. Hankins Apr. 1964 321 p
(Contract DA-04-495-ORD-3383(Z); ARPA Order 393-63) (Proj. Defender)
(GDA63-0174; AD-437498)

Equilibrium concentrations, and thermodynamic and normal shock properties were tabulated for various amounts of CH_2 in air, CH_2O in air, and pure atmospheres of N_2, O_2, CO_2. The solutions were obtained numerically by the method of minimization of free energy. A set of equilibrium constants for the formation of 91 species has been included. Author

N64-21243 Aerospace Corp., El Segundo, Calif. Plasma Research Lab.
SIMULATION OF A THIN PLASMA SHEATH BY A PLANE OF WIRES
K. E. Golden and T. M. Smith 30 Mar. 1964 35 p refs
(Contract AF 04(695)-269)
(SSD-TDR-64-29; TDR-269(4280-10)-3; AD-439244)

A method of simulating a thin plasma sheath of the type encountered in some aerospace applications by using a single plane of equally spaced wires is described. The surface impedance of such a periodic structure can be made equal to that of a thin plasma sheath. In this treatment, the respective surface impedances are related through three dimensionless parameters. A simple technique for obtaining high losses is also discussed, whereby collision frequencies in the neighborhood of the operating frequency are realizable. Experimental data, including both the lossy and lossless cases, are compared with the theoretical model in the X-band region. Author

N64-21269* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SECULAR AND NON-SECULAR BEHAVIOR FOR THE COLD PLASMA EQUATIONS
David Montgomery and Derek A. Tidman Washington, NASA, Jun. 1964 20 p refs
(NASA-TN-D-2305) OTS: $0.50

The origin of secular behavior for the nonlinear cold electron plasma equations is studied. The equations involved are closely related to the Klein–Gordon equation with a small nonlinear term. A method is developed for arriving at perturbation theoretic solutions of this equation, and the method is then applied to the case of the higher order effects of an electromagnetic wave propagating in the cold electron plasma. An explicit expression for the second-order frequency shift is calculated. Author

N64-21292 Technische Hochschule Hannover (W. Germany) Inst. für Theoretische Physik
EXCITATION OF PLASMA OSCILLATIONS BY SHOCK WAVES Technical Report
Jurgen-Dietrich Welly (Ph.D. Thesis) 1 Sep. 1963 57 p refs
(Contract AF 61(052)-161)
(AFCRL-63-577; AD-439209)

The velocity distribution of the electrons within a plasma shock front is investigated by methods of the kinetic theory arranged in a manner to account for heavy deviations from thermodynamic equilibrium. The distribution function exhibits two peaks and becomes unstable with respect to electron oscillations, the shock wave being sufficiently strong (Mach number $M \gtrsim 6.5$). The second peak is formed by runaway electrons, i.e., those fast electrons that transgress the shock front from the hot region. The frequencies, wave numbers, growth rates, phase and group velocities of the excited oscillations, and the influence of the Ohmic damping are calculated approximately. The results are applied to the nonthermal radio-frequency radiation of the sun. Author

N64-21306* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SECULAR AND NONSECULAR BEHAVIOR FOR THE COLD PLASMA EQUATIONS
David Montgomery and Derek A. Tidman (Maryland U.) Repr. from Phys. Fluids, v. 7, no. 2, Feb. 1964 p 242–249 refs
(NASA-RP-182)

The origin of secular behavior for the nonlinear cold electron plasma equations is studied. The equations involved are closely related to the Klein–Gordon equation with a small nonlinear term. A method is developed for arriving at perturbation theoretic solutions of this equation, and the method is then applied to the case of the higher-order effects of an electromagnetic wave propagating in the cold electron plasma. An explicit expression for the second-order frequency shift is calculated. Author

N64-21314 California Inst. of Tech., Pasadena Quantum Electronics Lab.
PLASMA DIAGNOSIS BY MEANS OF PHOTON-ELECTRON SCATTERING Scientific Report No. 6
S. E. Schwarz Bedford, Mass., AFCRL, 1 Feb. 1964 29 p refs
(Contract AF 19(604)-8052)
(AFCRL-64-242; AD-437790)

A brief summary of photon–electron scattering experiments is presented, and comments are made regarding their application to plasma diagnostics. The general field of gas discharge

afterglow studies is reviewed, and a summary of recent experimental studies of helium afterglow is presented. A photon–electron scattering apparatus has been used to perform experiments indicating the feasibility of afterglow studies using the Thomson scattering method. An impure helium discharge afterglow having properties that make it difficult to diagnose by other means has been studied by using laser scattering. The afterglow has also been examined spectroscopically, and the results are compared. Unexpected phenomena, which have been called "induced liminosity" and "giant scattering", have been observed. Author

N64-21355 General Dynamics/Astronautics, San Diego Calif. Space Science Lab.
INDUCTION PERIOD PRECEDING CO_2-FORMATION IN SHOCK HEATED CO-O_2-Ar MIXTURES
K. G. P. Sulzmann, B. F. Myers, Jr., and E. R. Bartle Feb. 1964 27 p refs
(Contract DA-04-495-ORD-3383(Z); ARPA Order 393; Proj. Defender)
(GDA-DBE-64-002; AD-438623)

The time history of the reaction processes occuring in shock heated mixtures of CO and O_2 in argon diluent [10% O_2 + 20% CO + 70% Ar, 10% C_2 + 10% CO + 80% Ar, and 5% O_2 + 10% CO + 85% Ar] was studied spectroscopically between 1,500° and 3,000° K by using spectral portions of the CO-fundamental and CO_2-ν_3-fundamental infrared bands and spectral portions of the CO-flame "continuum" emission. An induction period was observed that precedes the onset of measurable electronic ground state CO_2-formation and atomic oxygen production. The induction period is inversely proportional to the square roots of the initial mole concentrations of CO and O_2. The temperature dependence of the induction time can be interpreted by an apparent activation energy for the initiation of CO_2-formation, which varies from 21 kcal/mole at 1,500° K to 34 kcal/mole at 3,000° K. Addition of 0.1% H_2 results in a constant apparent activation energy for the induction period of 21 kcal/mole over the temperature range employed. Author

N64-21377 Laboratory for Electronics, Inc., Boston, Mass.
THE ARC SPOT AS A STEADY STATE EXPLODING WIRE PHENOMENON
Jerome Rothstein [1964] 15 p refs

In mercury-type arc spots, concentrated ionic bombardment of a small region is accompanied by intense emission of both electrons and an energetic vapor or plasma jet. On the basis of analysis, it is proposed that differences between arc-spot and exploding-wire phenomena are, mostly, in the details. Some of these differences are: (1) the importance of joulean heating and the minor role of ionic bombardment in the wire as compared to the arc spot; (2) "one-shot" nature of exploding wire compared to "machine-gun" ignition of cathode spots by arc d.c. supply; (3) greater geometric similarity of arc spot to exploding point (wire tip) than to the exploding line (wire); (4) magnetohydrodynamically induced instabilities and externally applied magnetic fields producing somewhat different phenomena; and (5) greater importance of boundary effects on spot properties. Therefore, the arc spot can be viewed as a steady-state exploding wire tip, because of localization that results from the key role of ionic bombardment in both ignition and maintenance of spot excitation. D.E.W.

N64-21397 Lincoln Lab., Mass. Inst. of Tech., Lexington
GROWING HELICAL DENSITY WAVES IN SEMICONDUCTOR PLASMAS Technical Report No. 320
C. E. Hurwitz (Ph.D. Thesis) 17 Oct. 1963 64 p refs
(Contract AF 19(628)-500)
(ESD-TDR-63-587; AD-432393)

A theoretical and experimental study is made of growing screw-shaped waves of electron-hole density in a semiconductor bar subjected to sufficiently large parallel electric and magnetic fields. The formulation of a physical model for the growth mechanism and motion of this helical wave shows that the wave may exhibit growth in two distinctly different forms. For unequal densities of positive and negative carriers, the growth is spatial, corresponding to unidirectional traveling-wave amplification. For equal or nearly equal carrier densities, the growth may be temporal, leading to instability. Growing helical waves may be obtained in a particularly simple physical configuration. All that is required is a uniform semiconductor bar with a low recombination surface, ohmic contacts, and moderate applied electric and magnetic fields. A detailed and quantitative mathematical description of the growth and propagation characteristics of the waves is presented. Expressions for the threshold fields and frequencies, growth constant, and phase constant for the case of stable spatial growth are derived. Author

N64-21447 Selenia S. P. A., Rome (Italy)
MICROWAVE INVESTIGATION OF THE DIELECTRIC WAVEGUIDE PROPAGATION BY MAGNETO-IONIC DUCTS Technical Final Report, 1 Oct. 1958–31 Dec. 1962
A. Gilardini Oct. 1963 88 p refs
(Contract AF 61(052)-145)
(AFCRL-64-219; AD-439213)

Theoretical work includes: discussion of the basic quasi-static and exact theories for propagation along plasma slabs and columns in magnetic fields; derivation of Brillouin diagrams; calculations of electromagnetic power flows; extension of theory to the case of external metallic walls; comparison with whistler-type characteristics; and approximate evaluation of propagation features in nonuniform and in warm plasma slabs. Experimental work includes: detection of plasma guided signals; measurements of their amplitudes; phase and group velocities; and check measurements of the electron density. Most of the experimental results are interpreted in terms of the discussed theories. Author

N64-21493 Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.
MECHANISM OF CESIUM IONIZATION
J. E. Creedon and S. Schneider Feb. 1964 6 p ref
(USAELRDL-TR-2434; AD-434814)

A theoretical model for the ionization of cesium vapor in the presence of a hot body and in the absence of an applied voltage sufficient to accelerate electrons to the ionization potential of cesium was formulated. The model was predicated on an inelastic two-body collision mechanism involving cesium atoms excited by light radiated from a hot body and was described by the reaction shown in the following equation:

$$Cs^* + Cs^* + K.E. \rightarrow Cs_2^+ + e.$$ Author

N64-21494 General Electric Co., King of Prussia, Pa. Space Sciences Lab.
INVESTIGATION OF NON-EQUILIBRIUM IONIZATION FOR MHD ENERGY CONVERSION Quarterly Report 15 Dec. 1963-15 Mar. 1964
B. Hoffman [1964] 19 p
(Contract AF 33(657)-8298)
(QR-8; AD-434574)

Work on the use of the self-induced electric field in an MHD generator for electrical breakdown of appropriate working fluids is discussed. During this report period, the work was directed toward the use of potassium for Rankine (vapor) cycles—a potassium blowdown run was conducted from blowdown tank conditions of 1,300° F and saturation pressure into the test channel operating at 1,440° F and 10^{-3}-mm Hg. Numerical calculations were performed to determine the effect of liquid droplets upon the transport of electrons in a partially condensed gas; a new model for the prediction of the degree of droplet charging has been derived, based on integer charging of the droplet; and the electron-negative droplet inelastic collision frequency has been modified. P.V.E.

25 PHYSICS, SOLID-STATE

Includes semiconductor theory; and masers. *For related information see*: 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

N64-20806* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

OXYGEN "PUMPING EFFICIENCY" OF REFRACTORY METALS

Charles A. Barrett and Louis Rosenblum *In its* Proc. of the NASA-AEC Liquid-Metals Corrosion Meeting, Vol. I 1964 p 307–312 refs (See N64-20783 14-01) OTS: $5.00

The gas being tested is continuously passed into the system through a controlled leak at the same time that a diffusion pump and the columbium alloy specimen are working to remove it from the system. Measuring the difference in pressure between two stations separated by a length of tube of known conductance allows calculation of the pumping rate of the specimen for any set pressure and temperature in the sample chamber. It is now possible to determine maximum total-oxygen-contamination pickup of Cb-1Zr, used in experiments run at advanced power-system temperatures in vacuum, by means of the Langmuir equation together with the experimental value of the pumping efficiency. A.W.

N64-20847 Naval Research Lab., Washington, D.C. Optics Div.

TRANSMISSION OF RUBY LASER LIGHT THROUGH WATER

J. A. Curcio and G. L. Knestrick Oct. 1963 12 p refs (NRL-5941; AD-412313)

The attenuation coefficients of filtered Potomac River water were measured at the ruby laser wavelength, 6,943A, and at 3 wavelengths in the green region of the spectrum where the attenuation is near the minimum. The path of the light beam, which was at a depth of 2.2 m, was varied from 6 to 36 m in the laser light observations and from 15 to 73 m for the green light observations. Narrow-band filters were used to restrict the passband of the system, and the field of view of the receiver was limited to 1.2°. The attenuation coefficient obtained at 6,943A was $5.45 \times 10^{-3}\ cm^{-1}$, and the value obtained at 4,900A was $8.6 \times 10^{-4}\ cm^{-1}$. Evidence was found for some small particle scattering. As an underwater light source, the ruby laser is severely handicapped by the fact that its emission occurs at a wavelength that is highly attenuated by water. Author

N64-20848 Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.

CORRELATION OF LASER THRESHOLD WITH THE OPTICAL QUALITY OF RUBY

C. M. Kellington, M. Katzman, and S. K. Poultney Dec. 1963 10 p refs (USAELRDL-TR-2408; AD-431243)

A program is discussed that was instituted to: (1) correlate optical parameters with crystal growth conditions; (2) correlate optical parameters with laser characteristics; and (3) relate the laser characteristics to the crystal growth conditions. The object of the program is to control the Verneuil method of growing ruby so that it yields optimum laser crystals. The threshold for laser action was measured for each crystal by noting the time delay between the flash-lamp pulse and the onset of laser emission for fixed-pump geometry and energy. A table is presented that lists the optical properties for crystals with high- and low-threshold regions for a given density. It is noted that, in general, the high-threshold crystals have more small-angle scatter, fewer parallel faces, less optical parallelism, larger linewidth, and a more uneven optical thickness than the low-threshold crystals. Large-angle scatter did not appear to be correlated to threshold. P.V.E.

N64-20850 Library of Congress, Washington, D.C. Aerospace Information Div.

SOVIET ADVANCED LASER PROPOSALS Surveys of Soviet-Bloc Scientific and Technical Literature [1956–1964]

13 May 1964 33 p refs (AID-P-64-35; AD-600291)

This review article covers the following areas: (1) controllable lasers based on the Zeeman effect, (2) gamma lasers, (3) fiber-optics lasers, (4) Raman scattering lasers, (5) plasma lasers, (6) chemical lasers, and (7) lasers based on organic materials. R.T.K.

N64-20865 Mithras, Inc., Cambridge, Mass.

THE ULTRAVIOLET ABSORPTION SPECTRA OF RUBY Scientific Report No. 1

Charles S. Naiman and Arthur C. Linz Oct. 1963 27 p refs (Contract AF 19(628)-2395) (MC-62-49-R1; AFCRL-63-581; AD-600293)

The ultraviolet absorption spectra of ruby have been studied in absorption and fluorescence. Measurements have been performed on heavily doped rubies of up to 4.3 percent Cr. These data have been correlated with excited-state absorption experiments performed on the long-lived ^2E level. The spectra are assigned on the basis of the simple crystal field theory, taking into account intensities and polarizations. The charge-transfer spectrum of $Cr^{+3}(d^3)$ in Al_2O_3 is also discussed. Evidence is found of spin forbidden bands (doublets) borrowing intensity from charge-transfer spectra. This probably explains the origin and intensity of the so-called "forbidden charge-transfer bands" from 40,000 to 50,000 cm^{-1} in ruby. Discussed in brief are details of the spectra, such as the trigonal field splitting, vibrational structure, and the "pair bands" at about 28,000 to 30,000 cm^{-1}. Author

N64-20877 European Atomic Energy Community, Brussels (Belgium)

BLOCKING OF DISLOCATIONS IN THE Al/Al_2O_3 ALLOYS [BLOCAGE DES DISLOCATIONS DANS LES ALLIAGES DU TYPE SAP/Al-Al_2O_3]

P. Guyot Joint Nucl. Res. Center, Ispra Estab. (Italy) Mater. Dept., Feb. 1964 13 p refs In FRENCH; ENGLISH summary (EUR-584.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

The blocking of dislocations by the alumina particles in the Al–Al_2O_3 alloy is studied. A model is proposed to calculate the activation energy of the unblocking process, under the influence of thermal agitation and applied stress. Previous experimental results showed a similar mechanism for the temperatures higher than 600° C; for the low temperatures, the deformation is probably proceeding by cross-slip and climb of dislocations in aluminum matrix. Author

N64-20903 Midwest Research Inst., Kansas City, Mo.
THE STRUCTURE AND STRENGTH OF EPITAXIAL FILMS Bimonthly Progress Report No. 3, 17 Feb.–17 Apr. 1964
Melvin Lavik, Arthur Cunningham, and Paul J. Bryant 15 May 1964 13 p
(Contract NOw-64-0061-d)
(AD-600149)

Most of the experimental equipment, designed for deposition and evaluation of epitaxial films on single-crystal substrates, was assembled. Discussions and photographs of the evaporation oven, substrate holder, vacuum system, and stress mechanism are presented. Brief reviews on the design of a strain measuring system and of plans for future work are given. Author

N64-20905 Hughes Research Labs., Malibu, Calif.
LASER DEVICES EXPLORATORY INVESTIGATION Interim Engineering Report No. 4, 3 Feb.–30 Apr. 1964
H. V. Winston [1964] 22 p refs
(Contract AF 33(657)-11650)
(AD-600267)

The fabrication and testing of sapphire quarter-wave plates for use with ruby in a novel longitudinal mode selector were completed. Testing of the elliptical pumping cavity for cw operation was started. A new setup made possible the growth of doped lanthanum trifluoride crystals of relatively high quality. Flame fusion techniques were used to make single crystal Gd_2O_3. The optical spectra of the newly grown $LaF_3:Pr^{3+}$ and Gd_2O_3 were obtained. Microwave spectra of chromium-doped LaF_3 were observed, and the identification of the resonances observed in terbium-doped LaF_3 was continued. Anomalies in the emission angles of anti-Stokes cones from various stimulated Raman scattering (SRS) materials were measured, and possible explanations examined experimentally. The most recent measurements show that both Stokes and anti-Stokes cones in typical SRS materials have angle spreads greater than 1° and wavelength spreads of the order of 20 A. Author

N64-20906 Stanford U., Calif.
REFLECTIONS IN AND FROM ONE-DIMENSIONAL REGULAR AND IMPERFECT POINT LATTICES Technical Report No. 1
Harold Levine 15 Apr. 1964 39 p refs
(Contract Nonr-225(74))
(AD-439609)

One-dimensional wave motions in a point lattice are investigated by envisioning a stretch string that is periodically loaded with identical point masses and is executing small transverse vibrations. The capabilities of an integral equation-transform analysis are illustrated with reference to wave motions along infinite strings that are loaded on only half of their total extension. In particular, expressions are obtained for the reflection coefficient of waves incident upon the loaded portion in cases where the latter contains either identical masses, an alternating sequence of two distinct masses, or an isolated departure from regularity in the mass spectrum. I.v.L.

N64-20929 Joint Publications Research Service, Washington, D.C.
PREPARATION OF SINGLE CRYSTALS OF CALCIUM FLUORIDE BY ZONAL FUSION
Ts'ui Feng-chu and Ch'uan Ning-san *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 98–101 refs Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 150–151 (See N64-20924 14-01) OTS: $3.00

The preparation of high-quality single crystals of adulterated calcium fluoride, from chemically purified and normally condensed natural fluorspar is discussed. The zonal fusion method is used to improve the purity of the crystals, and the homogeneity of the impurities and pyrometric treatment is employed to remove internal strain and to stabilize the state of the impurities. I.v.L.

N64-20930 Joint Publications Research Service, Washington, D.C.
THE EFFECT OF THE WORKING PARAMETERS OF RUBY PHOTON MAGNIFIER AND THE ENERGY OUTPUT OF STIMULATED EMISSION
Wang Chih-chiang, T'ang Hsing-li, Shen Kuan-ch'un, and Hua Chi-nien *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 102–110 ref Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 151–154 (See N64-20924 14-01) OTS: $3.00

Investigations concerning the effect of the following working parameters of a ruby photon multiplier upon the energy output of stimulated emission are discussed: (1) the electric capacitance; (2) the rate of penetration of the dielectric film; (3) the optical quality of the ruby rod; (4) the input energy of the xenon tube; and (5) adjustments of the harmonic oscillation "muzzle." The size of the ruby rod and the operating temperature of the multiplier also affect the energy output. An energy output of 1 j of stimulated emission was obtained with a 4.3-cm-long ruby rod having a diameter of 0.6 cm and operating at room temperature. An energy output of 10 j was obtained with a 9-cm-long ruby rod having a diameter of 1 cm at an operating temperature of −10° C. I.v.L.

N64-20931 Joint Publications Research Service, Washington, D.C.
X-RAY OBSERVATION OF THE SUB-STRUCTURE OF RUBY
Kung Tsai-chung, Chung Yung-ch'eng, and Feng Ming-yuan *In its* Transl. on Communist China's Sci. and Technol., No. 83 13 May 1964 p 111–113 refs Transl. into ENGLISH from K'o Hsueh T'ung Pao (Peking), no. 2, 1964 p 155–156 refs (See N64-20924 14-01) OTS: $3.00

An X-ray picture was made of the microscopic diffraction of a ruby crystal (grown by the Verneuil method) in the direction of the growth of the crystal and in the direction of its optical axis in order to observe the changes of the Lloyd spots before and after tempering. A close examination of the changes of these spots of the same species of ruby crystal, before and after tempering, showed that the perimeters of the spots were rather undefined before the tempering and clearly defined after high-temperature tempering. However, the cleavage and the direction of the cleavage of the spots were unchanged. This shows that the original substructure in the species has a resistance to heat. Thus, heat treatment can remove the elastic strain of the crystal, but it has no effect upon the substructure formed during the growth of the crystal. Therefore, the way to eliminate the substructure and to obtain a better single ruby crystal lies in the control of its growth conditions. I.v.L.

N64-20973 Motorola, Inc., Phoenix, Ariz. Solid State Systems Div.

DIFFUSION STUDIES ON STRESSED TANTALUM-TANTALUM OXIDE CAPACITORS

Neva Johnson and Kenneth Greenough *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 103–123 refs (See N64-20967 14-09)

(Contract AF 30(602)-2593)

Tantalum films, 3,000 A thick, evaporated on fused-quartz substrates and activated by neutron irradiation, were anodized at 82 v to form an oxide layer of approximately 1,600 A. Counterelectrodes of gold were evaporated on the oxide, and the completed thin-film capacitors were placed under thermal and electrical stress. The radioactive profiles of unstressed tantalum units show a pronounced variation of the tantalum-to-oxygen ratio from that of pure tantalum at the metal-oxide interface to a limiting value 600 A away from the interface. Application of thermal and electrical stresses alter the shape of the gradient and extend it several hundred angstroms further into the oxide layer. By normalizing the data with respect to the gradient formed by anodization in the unstressed unit, it was shown that thermal diffusion creates regions in the oxide near the tantalum interface where the tantalum concentration was depleted below that of the original unstressed unit and regions farther away from the interface where tantalum was in excess. Author

N64-20974 Burroughs Corp., Paoli, Pa.

SOLID-STATE THERMAL DIFFUSION: A CONTRIBUTOR TO DEGRADATION OF SEMICONDUCTOR JUNCTION DEVICES

Morris C. Johnson *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 124–144 refs (See N64-20967 14-09)

This paper is based upon the premise that metallic impurities diffuse into the bulk semiconductor regions of semiconductor junction devices, within the limit imposed by the solid solubility of these impurities. The subsequent ionization of these unwanted impurities causes certain electronic parameters of the junction to be altered in a predictable way; for example, the addition of these ionizable impurities near the physical interface at the junction causes a change in the electronic structure of the depletion layer, which is clearly evidenced by shifts in reverse-biased junction capacitance. The capacitive technique of measuring solid-state diffusion is examined in detail, and its application to the problem of describing failure in semiconductor junction devices is set forth. In addition to causing a shift in junction capacitance, the diffusion of impurities through the metal-semiconductor interface physically shifts the position of the junction from its original position at the interface into the bulk semiconductor region. Some of the results of this investigation are compared with field data provided by one vendor and with experimental data collected at these laboratories. At temperatures above 85°C, the agreement is good. Author

N64-20975 Pacific Semiconductors, Inc., Lawndale, Calif.

FAILURE MECHANISM IN SILICON

J. E. Mann and N. P. Sandler *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 145–153 refs (See N64-20967 14-09)

Dislocations are generated during phosphorus diffusion into silicon. The distribution of generated dislocations is directly related to the diffused impurity concentration profile. The position of the maximum number of generated dislocations is equal to approximately one-third the total diffusion depth as measured from the surface. With the usual high surface impurity concentration, the generated dislocations form a plane of relatively low mechanical strength at this position, which increases the probability of bulk cleavage failure when the structure is mechanically or thermally stressed. Removal or redistribution in a more random configuration of the generated dislocations eliminates this bulk failure mechanism. It is apparent that phosphorus-diffused silicon structures with or without generated dislocations react similarly to shear loads as long as the generated dislocations are not aligned to form a plane of relatively low mechanical strength. This is dependent on the number of generated dislocations and is valid at least within the limits of this study. Author

N64-20977 Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.

SILICON TRANSISTOR FAILURE MECHANISMS CAUSED BY SURFACE CHARGE SEPARATION

E. David Metz *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 163–172 refs (See N64-20967 14-09)

Surfaces are the prime factor limiting reliability in silicon transistors. The model describes these failures through movement of ionic contaminants on the top surface of the silicon oxide covering the junction regions. Factors affecting failure mechanism are: resistivity of the surface layers of silicon; cleanliness of surfaces; and the final atmosphere in the can after sealing. These factors were evaluated to establish the validity of the model. The applicability of the model to pnp devices as well as to npn was confirmed; however, an additional factor in regard to pnp transistors is that the presence of an oxide on high resistivity p-type collector regions tends to drive these surfaces toward inversion. This is a built-in effect unrelated to ion migration. A.W.

N64-20978 Research Triangle Inst., Durham, N.C.

A FUNDAMENTAL FAILURE MECHANISM IN THIN FILM METAL-DIELECTRIC STRUCTURES OBSERVABLE AS A GENERATED VOLTAGE

J. J. Wortman and R. M. Burger *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 173–187 refs (See N64-20967 14-09)

The majority of the data was obtained on aluminum–aluminum oxide–gold structures. Typically, a 2-mm-wide aluminum strip was evaporated onto a microscope slide. The thickness is not critical and is usually in the range of 500 to 1,000 A. An aluminum oxide layer about 150 A thick was grown by anodization in a 3%-tartaric-acid solution. At right angles to this, a gold stripe was evaporated. Both open-circuit voltage and short-circuit current decreases with increasing dielectric thickness. In the aluminum–aluminum oxide–gold structure the aluminum electrode is always negative. When aluminum is used for both electrodes, the behavior is the same as for the other structures, but either electrode can be negative. The results are in qualitative agreement with the galvanodiffusion model, although it has not been determined whether aluminum ions or vacancies or oxygen ions or vacancies are the current carriers. The galvanodiffusion effect is not limited to strongly oxidized materials but sets limits on thin-film capacitors. A.W.

N64-20986 Syracuse U., N.Y.

ON THE DEGRADATION OF GALLIUM ARSENIDE TUNNEL DIODES

R. L. Anderson *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 328–337 refs (See N64-20967 14-09)

Evidence is presented to the effect that the deterioration of gallium arsenide tunnel diodes is caused by and directly proportional to the true injection current. To measure deterioration, a 4-section wafer switch with 12 contacts per section was

mounted on a 1-rpm motor shaft; the peak current, valley current, and forward current were monitored once each minute. To assure constant temperature, the diode was immersed in a circulating-oil bath. The monitored currents were plotted on a strip-chart recorder. For comparison under different conditions, the voltage or temperature is varied during the test. A.W.

N64-20987 International Resistance Co., Philadelphia, Pa.
THE AGING MECHANISMS OF METAL FILM RESISTORS
John J. Bohrer and Charles W. Lewis *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 338–348 refs (See N64-20967 14-09)

Since metal films are produced by a rapid quenching process, it is to be expected that they will contain initially a number of unstable or metastable structures, such as lattice defects. In the case of alloy films, an additional aging mechanism is phase separation. Discontinuity is responsible for the negative temperature coefficients and abnormally high resistivities of very thin films. Generally, it can be said of aging processes in practical electronic systems that (1) time-dependent parameters change in the direction of greater stability; (2) certain phases of failure mechanisms may be suppressed by controlling test conditions; and (3) positive and negative changes occurring simultaneously may cancel in such a way that the lifetime is greater than when either acts alone. A.W.

N64-20991 Sylvania Electric Products, Inc., Woburn, Mass. Semiconductor Div.
IDENTIFICATION AND ELIMINATION OF A FAILURE MECHANISM IN SEMICONDUCTOR DEVICES
T. A. Longo and B. Selikson *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 424–435 refs (See N64-20967 14-09)

The failure mode was identified in a number of npn silicon planar epitaxial transistors as the very rapid formation of a ternary gold–aluminum–silicon compound or complex that is very weak and will cause the bond to open. This failure is eliminated by using aluminum instead of gold wires to make the bonded connections between the semiconductor and the leads or posts extending out of the transistor header. Strong stable bonds are thereby formed and show no degradation of mechanical or electrical quality even after hundreds of hours of baking at 300° C. A.W.

N64-20992 General Dynamics/Electronics, Rochester, N.Y. Quantum Physics Lab.
RELIABILITY OF GASEOUS OPTICAL LASERS USING NOBLE GAS ACTIVE MEDIA
Jack E. Taylor *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 436–449 refs (See N64-20967 14-09)

Whether this model can be extended to times of importance to reliability of long-lived gas lasers without considerable change in formulation is not known at present. Several simplifying assumptions about the sorption of oxygen in the presence of active rare gases were made. Considerable additional data must be obtained on the rate of electrical cleanup of oxygen in all glass laser systems before the analysis can be applied to operating systems. One area that has been neglected here, but which will be of importance, is concerned with how oxygen or other contaminants prevent or extract energy from the energy cycle used in the laser. A combination of optical- and mass-spectrometry will be required to provide detailed model parameters. In summary, this paper has pointed out some of the problems associated with the interaction of the rare-gas laser medium with discharge tube materials and contaminants. It is expected that a continuing study of the physical system interactions will lead to sufficient understanding of the various failure mechanisms of gas lasers that their reliability can be specified with relatively few simple measurements. Author

N64-20995 Shockley Transistor Corp., Palo Alto, Calif.
STACKING FAULTS AND FAILURE OF SILICON DEVICES
H. J. Queisser *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 476–481 refs (See N64-20967 14-09)
(Supported by the AF and AEC)

A stacking fault is a disturbance of the regular order with which lattice planes are stacked upon each other in order to give a certain crystal lattice. For silicon this lattice is the face-centered diamond structure. A special type of partial dislocation, called a stair-rod, is formed when a fault bends from one plane of (111) type into another. Another defect often observed in epitaxial layers is sometimes called the growth pyramid. Most faults originate at the interface between substrate and film. Stair-rod dislocations cause detrimental effects mostly by yielding nonuniform doping and by providing nucleation centers for impurity precipitation. Careful handling and various methods of gaseous etching prior to deposition reduce fault density, which must be avoided to insure device reliability. A.W.

N64-21009 General Precision, Inc., Pleasantville, N.Y. GPL Div.
NUCLEAR GYROSCOPE STUDY Final Report, Apr. 1960–Mar. 1961
J. H. Simpson Wright-Patterson AFB, Ohio, ASD, Apr. 1964 92 p refs
(Contract AF 33(616)-5715)
(A22-2; ASD-TDR-63-786; AD-600145)

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1. DETECTION OF FREQUENCY ERRORS IN A MAGNETIC RESONANCE OSCILLATOR, APPENDIX 1 I. A. Greenwood p 36–43 refs (See N64-21010 14-23)

2. OPTICAL PUMPING, APPENDIX 2 J. H. Simpson and J. T. Fraser p 44–85 refs (See N64-21011 14-25)

N64-21011 General Precision, Inc., Pleasantville, N.Y. GPL Div.
OPTICAL PUMPING, APPENDIX 2
James H. Simpson and J. T. Fraser *In its* Nucl. Gyroscope Study Apr. 1964 p 44–85 refs (See N64-21009 14-25)

A nuclear magnetic resonance controlled feedback oscillator is one containing in the feedback a magnetic resonance circuit that determines the frequency and phase of the oscillator. The magnitude of the net nuclear magnetization can be enhanced by illuminating the material containing the nuclei with circularly polarized resonance radiation along the direction of a weak magnetic field applied to the material. The dynamic motion of the magnetization can be monitored through the modulation of a beam of resonance radiation directed through the material perpendicular to the magnetic field direction. Such an oscillator with a mercury vapor resonance sample possesses several properties that make it advantageous for use in the construction of a nuclear gyroscope. Author

N64-21020 Dayton U., Ohio Research Inst.
COHERENT OPTICAL RADAR PARAMETERS AND TARGET REFLECTIONS Technical Documentary Report, 1 Jul. 1962–30 Jun. 1963
Werner R. Rambauske Wright-Patterson AFB, Ohio, Res. and Tech. Div., Apr. 1964 127 p refs
(Contract AF 33(657)-9014)
(RTD-TDR-63-4148; AD-600272)

The problem of the reflection of ruby laser pulses from artificial targets is investigated. The parameters of intensity

distribution over the cross section of a laser beam (in the 0.5- to 3-joule energy range), and the time history of this intensity within one pulse (in the 1/2- to 1-ms duration range) were measured and evaluated in different distances for the ruby rod up to 75 m. Reflection characteristics for different standard geometrical bodies and different standard surface materials were derived experimentally and theoretically for incoherent white illumination and were compared with laser illumination. The change of time history of a single pulse after reflection from the target, due to the targets shape, was studied. This change when compared with the undistorted pulse from the rear of the ruby permits conclusions about the shape of the target. Author

N64-21039 Oak Ridge National Lab., Tenn.
X-RAY FLUORESCENCE TABLES: LITHIUM FLUORIDE CRYSTAL
W. P. Amsbury, W. W. Lee, J. H. Rowan, and G. E. Walden
5 Jun. 1964 137 p refs
(Contract W-7405-ENG-26)
(Y-1470-C) OTS: $2.50

A critical compilation of standard reference tables of X-ray fluorescence lines has been published in convenient form for experimental use. This report contains tables calculated for a lithium fluoride crystal. Author

N64-21051 Massachusetts Inst. of Tech., Cambridge Lab. for Insulation Research
[OPTICAL MASER AND LIGHT MODULATION] Final Report, Feb. 1962–Jun. 1963
S. J. Allen, K. Linden, B. Di Bartolo, M. Mack, R. Peccei et al
[1963] 8 p refs
(Grant AF AFOSR-62-317)
(AD-428961)

Research activities have been conducted as follows: (1) Studies of coherent emission from ions in glass hosts showed that: (a) fluorescence lifetimes of such ions (rare earth) in glasses are determined by spontaneous emission rather than by radiationless processes; and (b) fluorescent line widths are broadened by variations in ionic environment to the order of 100 cm^{-1} to 200 cm^{-1}. (2) Optical harmonic generation in ammonium dihydrogen phosphate resulted in generation of coherent light in the green spectral region (5,300 A). (3) A rate equation analysis was made of optical maser emission. (4) An investigation of excited state spectroscopy and secondary absorption in optical masers is discussed. (5) Investigation of the extension of maser techniques to submillimeter wavelengths and of the problems of generation, detection, and modulation in this range were made. (6) An investigation of radiationless and phonon-assisted decay of excited ions in solids is discussed. P.V.E.

N64-21102 Battelle Memorial Inst., Columbus, Ohio Defense Metals Information Center
THE APPLICATION OF HIGH PRESSURE IN METAL-DEFORMATION PROCESSING REPORT ON AN INFORMAL SYMPOSIUM OF THE METALWORKING PROCESSES AND EQUIPMENT PROGRAM, OCTOBER 3, 1963
F. W. Boulger and B. A. Wilcox 2 Mar. 1964 74 p refs
(Contract AF 33(615)-1121)
(DMIC-199; AD-437328)

Past research, largely by Bridgman, has shown that superimposed hydrostatic pressure can significantly increase the ductility at fracture of various materials. These observations have stimulated considerable interest in applying this hydrostatic-pressure effect to metal deformation processing, where it was anticipated that improved ductility and fabricability of brittle materials could be realized. Hydrostatic extrusion and hydrodynamic compressive forging were two such fabrication techniques discussed, and preliminary results were found to be encouraging. Another fabrication process that will be investigated in the near future is sheet drawing, where the effect of superimposed pressure on drawability will be evaluated. Although it is generally observed that testing under high pressure improves the ductility to fracture, pressure cycling did not improve either the strength or ductility of steels containing various amounts of carbon. In addition to the mechanical-property effects, hydrostatic pressure measurably affected numerous metallurgical properties of metals and alloys. These include modes of deformation; kinetics of recovery, recrystallization, and grain growth; and phase stability. Author

N64-21153 Massachusetts Inst. of Tech., Cambridge
MICROMECHANISMS OF CLEAVAGE FRACTURE IN POLYCRYSTALLINE IRON Sixth Progress Report
Charles J. Mc Mahon, Jr. Washington, Natl. Acad. of Sci.–Natl. Res. Council, May 1964 61 p refs Prepared for Ship Structure Comm.
(Contract NObs-88279)
(SSC-161; AD-600515)

The initiation and propagation of cleavage microcracks in coarse-grained vacuum-melted ferrite, containing 0.035% and 0.007% carbon, were studied by means of tensile tests carried out between room temperature and −196° C, and by special metallographic procedures. The latter involved surface replication of prepolished tensile specimens at various stages along the stress–strain curve, and also the progressive sectioning of such specimens to reveal the internal details. In this way, the effects of carbides and mechanical twinning were related to the low-temperature yielding behavior, initiation and propagation of cleavage, and the ductile–brittle transition. Cleavage microcracks develop in ferrite during the strain-hardening portion of the stress–strain curve at low temperatures, and are initiated mainly by cracks that form in the carbides. A model for microcrack initiation by carbide cracking is proposed, and the conditions leading to brittle fracture are discussed. The applicability of these findings to the low-temperature brittle behavior of mild steel is also considered. Author

N64-21169 Massachusetts Inst. of Tech., Cambridge Energy Conversion and Semiconductor Lab.
THERMOELECTRIC PROCESSES AND MATERIALS Semi-Annual Progress Reports 4 and 5, Jan. 1, 1962–Jan. 1, 1963
Richard B. Adler et al 1 Jan. 1963 19 p refs
(Contract Nonr-1841(51))
(AD-601039)

Abstracts of the following investigations are included: (1) heat flow in crystal lattices; (2) design and construction of a thermoelectric generator to power a tunnel-diode d.c. converter; and (3) thermal and electronic transport properties of a Bi_2Te_3-Sb_2Te_3-Bi_2Se_3 semiconducting alloy. Progress is reported on research in the following areas: (1) investigation of the band structure of lead telluride; (2) a study of quantum-mechanical-transport theory in solids; (3) energy-band parameters of cadmium telluride; (4) low-temperature heat flow in crystal lattices; (5) magneto-optic effects in Bi_2Te_3; and (6) electron voltaic effect. R.T.K.

N64-21171 McMurry Coll., Abilene, Tex.
BRAGG ANGLES OF ALPHA QUARTZ
Gerald E. Montgomery 19 May 1964 8 p refs

The Bragg angles for several sets of atomic planes in alpha quartz have been measured using a double-crystal X-ray spectrometer. The instrument was calibrated using a calcite crystal

for which the Bragg angle for diffraction of the $CuK^{\alpha}1$ line is taken to be 14° 42'06". The results are obtained for five sets of planes most commonly used as reference planes in orienting piezoelectric elements. The results are believed to be accurate within ±06" of arc. Author

N64-21207 Nuklearni Institut Josef Stefan, Ljubljana (Yugoslavia)
H_3O^+ ION ENERGY BANDS IN ICE CRYSTALS
P. Gosar and M. Pintar Jan. 1964 11 p refs Submitted for Publication
(NIJS-R-424)

A theory of the energy bands and of the mobility of H_3O^+ ions in ice crystals is presented. The mobility is determined by the second order-processes, which involve the emission of one and the absorption of another phonon. The proton–phonon interactions are rather complicated because of the narrowness of the ion bands. The variational principle is applied to the Boltzmann equation to derive the mobility. Author

N64-21233 Radio Corp. of America, Princeton, N.J. David Sarnoff Research Center
RESEARCH STUDY FOR INCREASING THE SENSITIVITY OF PHOTOEMITTERS Quarterly Technical Report No. 9, 1 Jan.-31 Mar. 1964
R. E. Simon, A. H. Sommer, and W. H. Mc Carroll 15 Apr. 1964 40 p
(Contract DA-44-009-ENG-4913)

Attempts to produce S-20 photocathodes by a one-step process have so far only been successful in leading to a one-step process for S-24 (Na_2KSb) cathodes. Preliminary results from life tests on cathodes exposed to noncesiated tube parts indicated that life is limited. Electron diffraction studies of photocathodes deposited on room-temperature substrates by sequential deposition from molecular beams indicated that a good multialkali crystalline deposit does not result and this probably explains why good photocathodes are not produced by this method. Promising results are reported of experiments where simultaneous deposition of the cathode constituents by the molecular beam method is made. Preliminary results of experiments on photocathodes by using a quartz crystal oscillator as a mass detector and on cathode formation by flash evaporation are reported. An attempt to observe field-induced photoemission from germanium p-n junctions was not successful. Author

N64-21303* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THERMOLUMINESCENT KINETICS OF ALPHA-IRRADIATED ALKALI HALIDES
C. E. May and J. A. Partridge Repr. from J. Chem. Phys., v. 40, no. 5, 1 Mar. 1964 p 1401–1409 refs
(NASA-RP-177)

The kinetics of the thermoluminescence of single crystal NaCl, KCl, and KBr irradiated with 40-Mev alpha particles were investigated. Only one glow peak, composed essentially of a single emission band, was obtained for each of the salts investigated. To attempt complete analysis of the kinetics, both glow, curve and isothermal annealing experiments were employed. The results from glow curves were shown to be unreliable for calculation of the kinetic order in the case of NaCl and KBr. The isothermal tests indicate the kinetics of the dominant process for NaCl to be first order; for KBr, first order; and for KCl, 3/2 order. Author

N64-21316 Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
PARAMAGNETIC RELAXATION IN CRYSTALS Final Report, 1 May 1962-31 Oct. 1963
J. G. Castle, Jr. and D. W. Feldman [1963] 14 p refs
(Contract AF 19(628)-1640)
(AFCRL-64-307; AD-600089)

The results of the study include the following: (1) extension of the experimental technique to narrow lines (about 50 millioersteds wide), to very wide lines (more than 1000 gauss), and to very long relaxation times (many hours); (2) discovery of a novel temperature dependence of the spin-lattice relaxation time (approximately T^{-3}); (3) an attempted extension of relaxation theory relating the T^{-3} effect to low-frequency mechanical resonances at the defect sites; (4) establishment of the spin-lattice relaxation time intrinsic to the F-center in KCl by observing its dependence on temperature from 2.1° to 250° K and on magnetic field from 300 to 10,000 oersted to be independent of sample concentration; (5) fitting the theory of T_1 for F-centers to a physical model involving only magnetic hyperfine coupling; and (6) observation and preliminary identification of the strange, asymmetric shape of the paramagnetic resonance absorption due to Ti(+3) ions in corundum. Author

N64-21359 General Mills, Inc., Minneapolis, Minn. Research Dept.
ELECTRICAL CHARACTERISTICS OF GRAIN BOUNDARIES IN COMPOUND SEMICONDUCTORS Final Report
R. K. Mueller 28 Jun. 1963 20 p refs
(Contract AF 49(638)-628)
(Rept.-2404; AD-600321)

Indium antimonide was purified; single crystals were grown in low-index directions; and accurately oriented seeds were prepared. Various boundary structures were selected, and samples were prepared. Grain-boundary barrier effects were found to be strong in p-type material and weak, when present, in n-type material. Because of measurement difficulties, intensive surface studies were conducted, and it was found that anodized InSb, cooled in the dark, had an n-type surface that could be changed through a conductance minimum to a p^+ surface by controlled exposure to light. This technique allowed accurate boundary characteristic measurements, through which a high-conductance boundary inversion layer was discovered. Barrier capacitance and current flow across the barrier were measured and were found to agree well with values in the literature or as predicted by theory. D.E.W.

N64-21360 Naval Air Development Center, Johnsville, Pa. Aeronautical Electronic and Electrical Lab.
REDUCTION OF ANISOTROPY FIELD OF THIN MAGNETIC FILMS BY ANNEALING Foundational Research Phase Report
S. B. Greenberg 20 Jan. 1964 31 p refs
(NADC-EL-6369; AD-431233)

The effects of postdeposition magnetic annealing on the magnetic properties of thin permalloy films were investigated. It was found that the largest decrease in anisotropy field was produced by annealing in a field along the transverse axis of a film. Anisotropy field values of 1.5 oersteds were obtained with little increase in angular dispersion. Values less than 1.0 oersted were obtained, but with a substantial increase in dispersion. Changes in magnetic properties produced by annealing were reversible at temperatures below 350° C. Author

N64-21366 Nottingham U. (Gt. Brit.)
SEMICONDUCTIVITY OF ORGANIC FREE RADICALS Third Quarterly Report, 1 May-31 Jul. 1963

Kenneth W. Jones [1963] 8 p refs
(Contract DA-91-591-EUC-2019)
(AD-440814)

The energy gap of the free radical of α, α'-diphenyl-β-picryl hydrazyl was measured using both d.c. and a.c. The energy gap as measured for d.c. was 1.5 ev, as was predicted by the spectra. This is in good agreement with the measurements of Inokuchi, Aftergut, and Brown. The energy gap as measured for a.c. current was 0.3 ev, which is in close agreement with that of Eley and Parfitt. The a.c. results showed that the method may not be reliable, a true measurement of resistance is not achieved, and a dielectric loss is being measured. Also, the energy gap of the free radical of Würster's blue perchlorate is discussed. I.v.L.

N64-21370 Sylvania Electric Products, Inc., Woburn, Mass. Semiconductor Div.
DEVELOPMENT OF EPITAXIAL TECHNOLOGY FOR MICROELECTRONICS AND LARGE AREA DEVICE APPLICATION Quarterly Report No. 7, 1 Nov. 1963-31 Jan. 1964
P. Wang, B. Selikson, V. Sils, and R. Berkstresser 1 Jun. 1961 50 p
(Contract NObsr-85431)
(AD-431993)

The study of epitaxial layer thickness and resistivity for integrated circuit N/P material was completed. Work on epitaxial layer perfection was continued and the importance of the substrate perfection and surface cleaning established. The feasibility of three-point probe and junction capacitance techniques on a step-etched sample for the determination of layer doping profile was investigated. Experiments on "in situ" CO_2–$SiCl_4$ oxide growth immediately after epitaxial deposition were started. Epitaxial deposition on peripheral oxide-masked substrates was investigated. The Sylvania double-bevel technique was successfully used to determine doping profiles in N+ prediffused N/P planar circuit structures. Work on vapor phase deposition of thin silicon films on nonsilicon dielectric substrates was continued. Author

N64-21375 Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.
DEVELOPMENT OF MILLIMETER AND SUBMILLIMETER MASER DEVICES Interim Technical Report No. 3, 1 Oct. 1963-31 Jan. 1964
W. E. Hughes [1964] 30 p refs
(Contract AF 33(657)-10472)
(AD-432597)

The third reporting period was devoted to the study of iron-doped zinc tungstate as a possible new quantum amplifier material. The solutions to the spin Hamiltonian were obtained so that identification of energy levels is possible, and a computer program for the solution of radiation-induced transition probabilities was established. Since the dielectric constant of the zinc tungstate is considerably lower than that of the materials used previously, it was necessary to make several changes in the experimental apparatus. Several pumping techniques, including the five-level technique, will be investigated in zinc tungstate. During this period, operating points were chosen from the computer solutions of the Hamiltonian. Author

N64-21414 Westinghouse Electric Corp., Elmira, N.Y.
STUDY OF FIELD ASSISTED PHOTOCONDUCTIVITY Technical Documentary Report, Apr. 1, 1963-Apr. 1, 1964
V. J. Santilli Wright-Patterson AFB, Ohio, AF Avionics Lab., Apr. 1964 40 p refs
(Contract AF 33(657)-10703)
(AL-TDR-64-93; AD-600434)

Work was undertaken to investigate the fabrication and performance of a vidicon target that included a thin insulator layer. A model metal-insulator-semiconductor structure is postulated to develop the mechanism of carrier conduction through the target. Storage photoconductors and thin layers of various dielectrics are chosen to explore some of the structure details. Performance data, such as sensitivity and response time, are determined for the vidicon targets. The results indicate that certain characteristics of the photoconductor are changed with the inclusion of an insulator, but these are not necessarily explained by earlier appeals to a tunneling mechanism. A vidicon target with high sensitivity and good response time is developed, which may have many useful applications. Author

N64-21418 Columbia U., New York, N.Y. School of Engineering and Applied Science
MEGACYCLE DAMPING AND THE ELASTIC STIFFNESS COEFFICIENTS OF SINGLE CRYSTAL AND POLYCRYSTALLINE ARMCO IRON FROM ROOM TEMPERATURE TO 400°C Technical Report No. 5
Arthur E. Lord, Jr. (Ph.D. Thesis) Feb. 1964 145 p refs
(Contract Nonr-266(61))
(AD-435780)

The megacycle, pulse-echo internal friction method has been used to measure carbon and nitrogen Snoek damping peaks in α-iron in the temperature range of 300° to 400° C. The availability of the new diffusion data in this range shows that the diffusion of nitrogen in α-iron can be represented from −50° to at least 600° C by a single Arrhenius relation, $D = 4.30 \times 10$ exp $[-18{,}260/RT]$ $\frac{cm^2}{sec}$ and that of carbon from −40° to at least 350° C by $D = 4.30 \times \exp[-19{,}170/RT]$ $\frac{cm^2}{sec}$. Reliable values have been obtained for the elastic stiffness coefficients of single-crystal iron at room and liquid-nitrogen temperature. Also certain single-crystal stiffnesses have been obtained up to 400° C. The orientation of the nitrogen Snoek relaxation in P-iron has been verified in a more complete manner. Magnetic damping peaks due to carbon have been seen at 7 mc/sec. N.E.A.

N64-21428 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
VISIBLE RADIATION DAMAGE EFFECTS OF 40-MEV ALPHA PARTICLES ON SODIUM CHLORIDE CRYSTALS
Michael Hacskaylo and C. C. Giamati Washington, NASA, Jun. 1964 15 p refs
(NASA-TN-D-2329) OTS: $0.50

The bombardment of sodium chloride crystals with high fluxes ($>10^{14}$ particles/cm^2) of 40-Mev alpha particles, whose computed range is 0.72 mm, produces a damaged planar region normal to the alpha beam near the end of the range. The irradiated crystals are colored throughout the portion between the incident surface and a plane parallel to this surface at a depth of 0.73 ± 0.01 mm. The damaged region is characterized by (1) a line of discontinuity of the surface cleavage pattern at the coloration limit on surfaces parallel to the beam, (2) a plane of "easy" cleavage at various depths between 0.43 and 0.62 mm, and (3) crystallographic cavities that appear after the crystals are heated to 400° C. Author

N64-21435 Johns Hopkins U., Baltimore, Md. Carlyle Barton Lab.
VIBRATIONAL AND ROTATIONAL ENERGY LEVELS Final Report, Apr. 1959-Aug. 1963
Jan M. Minkowski, John B. Newman, James J. Whalen, and Robert L. Armstrong Wright-Patterson AFB, Ohio, Res. and Tech. Div. 30 Sep. 1963 23 p refs
(Contract AF 33(616)-6457)
(WR-AF-5; RTD-TDR-63-4110; AD-428220)

Two molecular systems, each having behavior that undergoes only slight changes in certain solid-state environments, have been studied. The first, a polar molecule in an inert gas crystal, is of interest because the constraints on the molecular rotation, including electronic correlation effects, are expected to be small. The second, the uranyl complex in an ionic solid, was studied because of the interactions between the lattice vibrations and the persistent uranyl vibrations. The results of these studies, which are continuing, are given in this report. Author

N64-21443 Naval Research Lab., Washington, D.C. Radiation Div.
NORMAL SPIN-WAVE MODES OF COMPLEX EXCHANGE-COUPLED CRYSTALS
A. W. Sáenz 31 Jan. 1964 6 p refs
(NRL-6031; AD-437955)

A spin-wave theory was constructed of the Holstein–Primakoff type applicable to exchange-coupled crystals with an arbitrary number of magnetic ions per primitive magnetic unit cell. A simple, explicit, and general procedure is given for finding a complete set of normal spin-wave modes within the context of the above theory. A comparison of the procedure with the corresponding one of Wallace reveals that the present method is considerably easier to apply than his in practical computations involving an extensive class of complex exchange-coupled spin structures. Author

N64-21470 Air Force Cambridge Research Labs., Bedford, Mass. Electromagnetic Radiation Lab.
DEPENDENCE OF ORIENTATION AND MAGNON THRESHOLD POWER DURING PARALLEL PUMPING, USING A SINGLE CRYSTAL MANGANIN-MAGNESIUM-COBALT-FERRITE
W. Haubenreisser and D. Linzen Feb. 1963 22 p refs Transl. into ENGLISH of an article from Phys. Stat., v. 2, 1962 p 734 refs
(AFCRL-63-55; AD-407368)

The orientation dependence of the critical microwave field strength is being investigated only for the subsidiary absorption in the parallel field of a single-crystal sphere of Mn-Mg-Co ferrite. The experimental results can be explained through the Morgenthaler–Schlömann theory by taking into consideration elliptically polarized S-magnons, which satisfy the conditions of a magnetic anisotropy dispersion, if the crystalline anisotropy field is fluctuating spatially. Author

N64-21471 Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.
INVESTIGATION OF SINGLE-CRYSTAL AND POLYCRYSTALLINE TITANIUM DIBORIDE: MICROSTRUCTURAL FEATURES AND MICROHARDNESS [Progress] Report, Jun. 1961-Oct. 1963
S. A. Mersol, C. T. Lynch, and F. W. Vahldiek Apr. 1964 109 p refs
(ML-TDR-64-32; AD-600519)

A Widmanstätten precipitate was observed in the basal (c) plane of the crystal. This line or platelet pattern occurs in the expected crystal habit with triangular or rhomboid configurations at 60° or 120° angles. In the prism (a) planes, which are perpendicular to the basal plane, the platelets or lines of the Widmanstätten precipitate were viewed as parallel lines. A variation of this pattern occurs with harsher etching procedures to produce an acicular structure. Evidence of slip lines, dislocations, and subboundaries was found. The effects of annealing on the microstructure were investigated. Below 2,100° C the effects are slight, above 2,300° C the Widmanstätten precipitate is dispersed throughout the matrix. Variations in Knoop microhardness were correlated with orientation and structural imperfections in the crystals. The effect of various etchants on the microhardness was investigated. Optimum results were achieved with a 100-gram load. Indentations were classified into the classic six cracking classes. The highest values obtained were 3,250±150 kg/mm^2 for unannealed specimens and 3,710±250 kg/mm^2 for annealed specimens. Author

N64-21475 Tyco Labs., Inc., Waltham, Mass.
POWER-DENSE THERMOELECTRIC MODULE, PHASE IV: SOLIDIFICATION OF THERMOELECTRIC MATERIALS UNDER THE INFLUENCE OF ULTRASONIC AGITATION Progress Report No. 2, Period through 30 Sep. 1963
Martin Weinstein and A. I. Mlavsky [1963] 22 p refs
(Contract NObs-86015)
(AD-431558)

The compressive strength of N-type PbTe was related to the grain diameter, D, by the Petch relation: $\sigma_c = \sigma_i + KD^{-1/2}$. Extrapolation of the experimental data to infinite grain diameter yields a fracture strength of 5,000 psi for single crystal PbTe. The ultrasonic technique employed for the preparation of N-type PbTe was applied to the solid solution system, PbTe-SnTe (70-30). The average room-temperature resistivity of all the prepared ingots fell in the range of 2 to 4 × 10^{-4} ohm-cm. The average Seebeck coefficient α0 to 500° C = 145μv/° C. Extensive improvement was obtained in the overall structure of the P-type ingots. Author

N64-21488 Naval Research Lab., Washington, D.C. Optics Div.
OPTICAL TESTS ON SOME RUBY SAMPLES
J. N. Bradford, R. C. Eckardt, and J. W. Tucker 6 Mar. 1964 25 p
(ARPA Order 306-62)
(NRL-6080; AD-431300) OTS: $0.75

Six samples of ruby crystals have been subjected to several optical tests. The four types of tests performed are based on optic axis figure, shadowgraphs, examination between crossed polarizers, and small-angle scattering. The test results are presented primarily in photographic form. Optic axis figures were reasonably good in all but one of the samples examined. The shadowgraphs show striae in all of the samples and in some, wedges resulting from relatively uniform refractive-index gradients. One sample shows no small-angle scattering. In the other samples small-angle scattering is quite variable and is strongly dependent on direction of transmission through the crystals. Examination between crossed polarizers provided no additional information. Author

26 PROPELLANTS AND COMBUSTION

Includes fuels; igniters; and oxidizers. *For related information see*: 07 Chemistry; and 27 Propulsion.

N64-20744* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
SPACE-CABIN ATMOSPHERES. PART II – FIRE AND BLAST HAZARDS A Literature Review

Emanuel M. Roth Washington, NASA, 1964 126 p refs
(Sponsored by NASA)
(NASA-SP-48) GPO: $1.00

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5. FIRE AND BLAST HAZARDS FROM METEOROID PENETRATION p 47–77 refs (See N64-20749 14-16)

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7. ROLE OF FIRE AND BLAST HAZARD IN SELECTION OF SPACE-CABIN ATMOSPHERE p 99–108 refs (See N64-20751 14-26)

N64-20745* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
DEFINITION AND THEORY
In its Space-Cabin Atmospheres, Pt. II 1964 p 1–21 refs (See N64-20744 14-26) GPO: $1.00

This report covers each phase of the combustion picture: ignition, flame propagation, detonation, and flame extinguishment. The theoretical role of oxygen and the inert gases, as they affect each phase of the combustion process, and the environmental variables presented by the total space cabin conditions, which modify these phases, are discussed. I.v.L.

N64-20746* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
EFFECTS OF ATMOSPHERIC ENVIRONMENT ON FLAMMABILITY OF FABRICS AND CARBONACEOUS SOLIDS
In its Space-Cabin Atmospheres, Pt. II 1964 p 22–29 refs (See N64-20744 14-26) GPO: $1.00

Effects of atmospheric environment on flammability of paper, fabrics, and carbonaceous solids include the following: (1) An increase in altitude to 40,000 ft in the atmospheric air environment prolonged the combustion time of paper strips along a sigmoid curve from 7 to about 17 sec. At constant oxygen partial pressure, increasing the altitude decreased the combustion time. Combustion of fabric from very light flying suits responded in the same general way. (2) The burning time of cotton fabric decreased as the proportion of oxygen in the atmosphere increased, under any fixed nitrogen partial pressure. (3) Helium offered no great advantage over nitrogen with respect to the fire hazards of burning fabrics. (4) The flame speeds of cotton, wool, and wool-Terylene mixtures were increased when oxygen was added to the atmosphere, and the residues of carbon and ash decreased steadily. When the flame speeds of the woolen fabrics were increased by only slight additions of oxygen, the strips burned completely, although the flame speeds were very much lower than those of cotton fabrics. (5) The flame retardant boric acid–borax mixture, which was used to impregnate cotton drill, was the most effective retardant tested at lower concentrations of the retardant and in higher oxygen concentration. An optimum weight of 10% retardant would afford protection in atmospheres containing 32% of oxygen. (6) Most materials of carbonaceous nature exposed directly to the atmosphere burned completely in 100% oxygen. I.v.L.

N64-20747* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
EFFECTS OF ATMOSPHERIC ENVIRONMENT ON FLAMMABILITY OF GASES, LIQUIDS, AND VAPORS
In its Space-Cabin Atmospheres, Pt. II 1964 p 30–38 refs (See N64-20744 14-26) GPO: $1.00

Included in this report are data on the following: (1) the flame speed of methane, acetylene, propane, and hydrogen in varying concentrations of the inert diluents, nitrogen, argon, and helium; (2) the flame temperature of methane, propane, and acetylene in nitrogen, argon, and helium of varying concentrations; (3) the limits of flammability of the fuel gases, methane and hydrogen, in mixtures of 21% oxygen and 79% inert gas (carbon dioxide, nitrogen, helium, neon, and argon); (4) the minimum spontaneous-ignition temperatures of various MLO and MIL-H-5606A hydraulic fluids in oxygen–nitrogen atmospheres at 1 atm pressure, in contact with a Pyrex glass surface, as a function of oxygen concentration; (5) the effect of oxygen partial pressure on the minimum autoignition temperatures of JP-6 fuel mixed with oxygen and nitrogen at various initial pressures; (6) the minimum spontaneous ignition temperatures of the hydraulic fluids of (4) in air at 1 atm pressure, in contact with a Pyrex glass surface, as a function of diesel injector pressure; (7) the ignition temperature at varying oxygen pressures for MIL-O-5606, JP-4, MLO-8200, MIL-H-8446A, and MLO-7117; and (8) the comparative ignition temperatures, at varying altitudes, of the following aircraft fluids: MIL-O-5606, MLO-8200, G.E. #81644 and MIL-H-8446A hydraulic fluids; JP-4 aviation fuel; MIL-O-7808 lubricating oil; and MLO-7117 naphthenic mineral oil. I.v.L.

N64-20748* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
EFFECTS OF ATMOSPHERIC ENVIRONMENT ON ELECTRICAL FIRE HAZARDS
In its Space-Cabin Atmospheres, Pt. II 1964 p 39–46 refs (See N64-20744 14-26) GPO: $1.00

The potential hazard of insulating materials was investigated by means of three basic tests: (1) the determination of the amount of current that causes wires to burn in various atmospheres; (2) measurement of the effect of various atmospheres in propagating flame from a shorted wire to adjacent wires; and (3) measurement of the effect of various atmospheres when extreme current is passed through wire. Results indicated that: (1) Asbestos-insulated wire, in general, appears to be best as far as fire hazard is concerned. (2) Silicone rubber-glass-Dacron insulation, in the absence of nitrogen, appears safer than does the polyvinyl chloride insulation. Only when the partial pressure of nitrogen is increased to the point where it is more than six times that of oxygen does the polyvinyl chloride-insulated wire appear to be safer. (3) The glass-Teflon wire appears to be superior to the silicon rubber-glass-Dacron wire in both the adjacent-wire and extreme-current

tests. However, there is a question regarding the toxicity of burning Teflon. The pyrolysis products of Teflon produce a syndrome similar to "metal fume fever." Also, the burning characteristics of the various aircraft wires used in the tests are discussed. I.v.L.

N64-20750* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
PROBLEMS OF FIRE PREVENTION AND EXTINGUISHMENT IN SPACE CABINS
In its Space-Cabin Atmospheres, Pt. II 1964 p 78–98 refs
(See N64-20744 14-26) GPO: $1.00

Sources of fires, selection of optimum structural materials, location of equipment, flame, heat, carbon monoxide, vapor, and pressure detectors, and protective clothing and structures are discussed in the light of fire prevention in space cabins. Also, the advantages and disadvantages of the following extinguishing methods, in an environment (space cabin) subjected to a probable scattering effect at zero gravity, are discussed: (1) a manual extinguishing system; (2) an automatic extinguishing system; (3) explosion suppression; and (4) evacuation. I.v.L.

N64-20751* Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
ROLE OF FIRE AND BLAST HAZARD IN SELECTION OF SPACE-CABIN ATMOSPHERE
In its Space-Cabin Atmospheres, Pt. II 1964 p 99–108 refs
(See N64-20744 14-26) GPO: $1.00

The ultimate decision on the weighing of fire and blast hazard in the selection of a space-cabin atmosphere will be made on a semiquantitative level with intuition playing a major role. The safest cabin atmosphere is air at reduced pressure. The 8,000-ft atmosphere used in current high-altitude aircraft cabins is about as safe as can be in the tradeoff between fire and blast hazard and physiological hazard. The sensitivity of response of each combustion parameter to elevation in the percentage of oxygen is different. Minimum ignition energy for electrostatic sparks is probably the most sensitive. Other parameters follow behind with varying degrees of sensitivity. It is difficult to arbitrarily set a given limit for tolerable hazard even in such clear-cut factors as minimum spark-ignition energies on rates of the burning of fabrics. As to the choice of inert gases, helium appears to be safer than nitrogen as far as spark-ignition parameters are concerned, but is a much poorer choice in the case of the rate of burning of premixed gaseous systems. Nitrogen is probably safer than helium. Neon lies between helium and nitrogen in narrowing the limits of flammability in hydrogen–oxygen systems. I.v.L.

N64-20839 Sonotone Corp., Elmsford, N.Y.
DESIGN AND MANUFACTURE OF SEALED NICKEL-CADMIUM CELLS OF CYLINDRICAL DESIGN TO SIGNAL CORPS TECHNICAL REQUIREMENT SCL-7504 A Final Report, Dec. 1, 1959-Mar. 31, 1963
Francis Alliegro [1963] 102 p refs
(Contract DA-36-039-SC-84496))
(Rept. 4; AD-407111)

The 60 cells of each of three sizes, 10 amp hr, 50 amp hr, and 100 amp hr, were manufactured. The qualification tests of SCL-7504A were successfully passed, and all cells were delivered. All 10-amp hr and 50-amp hr cells had teflon sealed terminals. In the 100-amp hr size, 40 cells had teflon seals and 20 cells had ceramic seals. Fifty each of the 50-amp hr and 100-amp hr cells were partially scored to immobilize the core assembly to withstand the severe vibration and shock requirements of SCL-7504A. Parts lists and pertinent drawings of all types of cells were included in this report. Author

N64-20846 Naval Ordnance Lab., White Oak, Md. Chemistry Research Dept.
ANALYSIS OF THE OPTICAL DETERMINATION OF DETONATION VELOCITY IN SHORT CHARGES
A. Robert Clairmont, Jr. and Irving Jaffe May 1964 31 p refs
(NOLTR-64-23; AD-600059)

A transformation equation was derived whereby the data from smear camera records of the peripheral detonation of a short (L/D of 2.5) tetryl charge can be interpreted to obtain a detonation velocity measurement. The results are in excellent agreement with the values measured along the axis as well as with those published in the literature. Author

N64-20851 Stanford Research Inst., Menlo Park, Calif.
HIGH ENERGY OXIDIZERS IN SOLUTION Quarterly Technical Progress Report No. 3, Jan. 1-Mar. 31 1964
W. E. Tolberg and M. E. Hill 30 Apr. 1964 15 p ref
(Contract AF 04(611)-9370; ARPA Order 24)
(AD-439413)

The conductivity of NF_3 dissolved in liquid HF was determined to be no greater than 3×10^{-5}/ohm cm, the conductivity of the solvent being used. From the conductivity and estimated equivalent conductances, the concentration of ions was calculated to be no more than about 10^{-4} mols/liter. With improved HF, this limit is expected to be a factor of 10 to 100 less. Author

N64-20853 Stanford Research Inst., Menlo Park, Calif.
SOLID PROPELLANT MECHANICAL PROPERTIES INVESTIGATIONS Second Quarterly Progress Report, Jan. 1-Apr. 1, 1964
Norman Fishman and James A. Rinde 20 Apr. 1964 49 p refs
(Contract AF 04(611)-9559)
(Rept. 6; AD-439403)

Continued progress was made toward developing a method for defining the path-independent physical state of a propellant in terms of stress–strain–time history. The general form of the dilatational state equation, developed by least squares curve fitting of all constant strain rate test data, is as follows:

$$\log V/V_0 = A\,[\log W + B(\log t/b_T) + C(\log t/b_T)^2]^n.$$

Analysis of test data by application of the modified finite elastic theory continued. Considerable development of this method of data analysis remains to be done, but significant progress toward effective material characterization was made. Results of all tests to date are presented in either tabular or graphical form. Preliminary results of tests of two model systems based on the polybutadiene binder (one with glass beads, the other with aluminum powder) and results of studies of the effects of moisture on dilatation are also discussed. Author

N64-20857 Marquardt Corp., Van Nuys, Calif.
CY 1963 RAMJET TECHNOLOGY PROGRAM. VOLUME II: RAMJET STRUCTURAL COMPONENT INVESTIGATIONS Second Quarterly Progress Report, 20 May-11 Aug. 1963
J. R. Campbell 9 Sep. 1963 41 p refs
(Rept. 25092)

Three areas of research are discussed: (1) The application evaluation of ramjet structural elements, utilizing advanced material systems, is being carried out for the purpose of extending the state-of-the-art of high-temperature material systems and of determining the utilization capabilities of these new material systems for ramjet component applications. (2) Experimental evaluation of nonregeneratively cooled combustion chambers and nozzles has resulted in conception and evaluation of a new design applicable to radiation-cooled combustion chambers. (3) In studying high-temperature coated-tungsten structures, it is concluded that as a result of systematic elimination

according to phase relationships, microstructure, thermodynamic and physical properties, oxidation products, and experimental data, the materials applicable as coatings for tungsten substrates have evolved to hafnium-based systems with alloying additions of tantalum, titanium, silicon, and yttrium. P.V.E.

N64-20867 Gt. Brit. Ministry of Aviation, Mottingham Technical Information and Library Services
SELECTION OF THE OPTIMUM PARAMETERS OF A SUPERSONIC RAMJET ENGINE WITH A HEAT EXCHANGE [VYBOR OPTIMAL'NYKH PARAMETROV SVERKHZVUKOVOGO PRYAMOTOCHNOGO REAKTIVNOGO DVIGATELYA S TEPLOOBMENNYM APPARATOM]
V. T. Vorogushin Apr. 1964 9 p refs Transl. into ENGLISH from Izv. Vyssh. Uchebn. Zavedenii, Aviats. Tekh. (USSR), v. 4, 1961 p 75–81
(TIL/T. 5396)

An investigation of the influence of flight parameters on the working characteristics of a ramjet engine is discussed. Thermal and aerodynamic design of the engine was considered, and suitable parameters for this and for the exchanger were derived. Author

N64-21046 Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
THE PRINCIPAL OF OPERATION AND APPLICATIONS OF A SKIMMER NOZZLE
A. Lucile Cox Mar. 1964 31 p refs
(R-90)

The principle of operation of a skimmer nozzle and reported studies with such a configuration are described. The development of a condensation colloidal ion source that incorporates a skimmer nozzle is presented. The requirements are cited for such a colloidal ion source to serve efficiently in an electrostatic propulsion engine or as a high-voltage, charge-transport-power-converter. The possibility of using the skimmer nozzle technique for synthesis of unusual chemical substances, cluster ions, or charged bodies is also examined. Possible improvements in the performance of chemical or nuclear rocket engines operating with a skimmer nozzle are discussed. Author

N64-21061 Rocketdyne, Canoga Park, Calif. Research Dept.
RESEARCH IN THE CHEMICAL, PHYSICAL, AND METALLURGICAL SCIENCES Final Report, 25 Jun. 1962-10 Dec. 1963
B. L. Tuffly et al Edwards AFB, Calif., AF Flight Test Center, Feb. 1964 160 p refs
(Contract AF 04(611)-8502)
(R-5462; RTD-TDR-64-21; AD-432599)

The current program was directed toward advancing the state-of-the-art of analytical chemistry as applied to rocket propellants. Specific efforts discussed include: (1) development of a fast-responding, highly sensitive detector for electroactive materials in gases and liquids; (2) development of techniques for chemical analysis of cryogenic materials; and (3) establishment of the chemical structure of pentaboranehydrazine firing residues. Author

N64-21295 Denver Research Inst., Colo. Chemistry and Chemical Engineering Div.
SYNTHESIS AND EVALUATION OF HIGH-ENERGY ORIENTED POLYMERS Final Report, 27 Mar. 1961–27 Mar. 1962
Don N. Gray, Claibourne D. Smith, and Francis S. Bonomo Eglin AFB, Fla., ASD, [1962] 25 p refs
(Contract AF 08(635)-1938)
(ASD-TDR-62-115; AD-283263)

In connection with a study of polymers containing high-energy groups, poly(2-nitro-2-methylpropyl methacrylate) was prepared in both the isotactic (m.p. above 300° C) and the atactic (m.p. 280° C) forms. Isotactic poly(2-nitro-2-methylpropyl methacrylate) was prepared by adding the monomer to a relatively large amount of toluene containing phenylmagnesium bromide as a catalyst. Atactic poly(2-nitro-2-methylpropyl methacrylate) was prepared by a conventional free radical-type polymerization using azobisisobutyronitrile. Similarly, isotactic poly(methyl methacrylate) (m.p. 140° to 160° C) was prepared and compared with a commercially available sample of atactic poly(methyl methacrylate) (m.p. 120° to 125° C). Contrary to previous observations that the isotactic form of a polymer had higher mechanical strength than the atactic form, atactic poly(methyl methacrylate) had a higher tensile strength than the isotactic modification. Author

N64-21317 Bureau of Mines, Pittsburgh, Pa.
IGNITION CHARACTERISTICS OF FUELS AND LUBRICANTS [Summary] Report, 1 Jan.-31 Dec. 1963
Joseph M. Kuchta, Alphonse Bartkowiak, Ralph J. Cato, and Michael G. Zabetakis Wright-Patterson AFB, Ohio, Aero Propulsion Lab., Dec. 1963 40 p refs
(Contract DO-33(657)-63-376)
(APL-TDR-64-25; AD-600002)

Ignition temperatures of n-hexane, n-octane, n-decane, JP-6 jet fuel, and aircraft engine oil MIL-L-7808 (0-60-18) were determined in air using heated Pyrex cylinders of 0.314-in. to 1.38-in. diameter and Nichrome wires, rods, or tubes of 0.016-in. to 0.75-in. diameter. The ignition temperature varied little with fuel–air ratio but increased as the size of the heat source was decreased. Expressions are given that define the variation of the hot surface ignition temperatures of these combustibles with the radius and the surface area of the heat source. The expressions are applicable to stagnant or low-velocity flow conditions (< 0.2 in./sec). In addition, the hot gas ignition temperatures of the combustible vapor–air mixtures were determined with 1/4-, 3/8-, and 1/2-in.-diam jets of hot air. These ignition temperatures also varied little with fuel–air ratio and increased as the diameter of the heat source was decreased. Author

N64-21408 Lehigh U., Bethlehem, Pa. Inst. of Research
THE MECHANISM OF EXPLOSION INITIATIONS IN THE STANDARD IMPACT SENSITIVITY TESTER Final Report
Morton P. Moyle and A. J. Fedor Edwards AFB, Calif., Rocket Propulsion Lab., Mar. 1964 45 p refs
(Contract AF 04(611)-9063)
(RPL-TDR-64-61; AD-600603)

Experimental impact sensitivity data was obtained for normal propyl nitrate as the condensed phase with gas bodies consisting of the single component systems—argon, helium, nitrogen, Freon-12; binary systems—helium–oxygen, nitrogen-oxygen, Freon-12–oxygen; and the ternary system—Freon-12/Helium—Oxygen. The experimental program has separated for the first time the effects of heat capacity ratio, thermal conductivity, and chemical reactivity of the gas body on the impact sensitivity. Based upon a theoretical model of initiation proposed, the impact sensitivity of n-propyl nitrate was correlated with the thermal diffusivity of the entrapped gas body. The correlation correctly predicts that argon, nitrogen, and Freon-12 gas bodies require energies above 92 kg/cm for initiation to occur. The effect of chemical reactivity of the gas body was also accounted for. Author

27 PROPULSION

Includes airbreathing, electric, liquid, nuclear, and solid propulsion. *For related information see*: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N64-20779 Joint Publications Research Service, Washington, D.C.

FORCES ON SHIPS' RUDDERS AND SCREW PROPELLERS

In its Control and Stability in Ship Design 12 May 1964 p 133–200 refs (See N64-20776 14-11) OTS: $6.00

The following are discussed: (1) an isolated rudder; (2) reaction of a rudder with the free surface, the hull, and the screw; (3) the moment on the rudder stock; (4) cavitation of rudders; (5) special devices providing steerability; and (6) forces appearing on screw propellers when maneuvering. R.T.K.

N64-20808 General Electric Co., Philadelphia, Pa. Space Sciences Lab.

PLASMA ACCELERATOR RESEARCH CAPABILITY AT THE SPACE SCIENCES LABORATORY

[1963] 37 p refs

Projects that have been carried out or are currently in progress are discussed. These include: (1) the physics of reentry plasmas 1956–1959; (2) pulsed T-tube plasma-accelerator studies 1958–1959; (3) pulsed coaxial plasma-accelerator studies 1959 to present; (4) the cyclotron resonance plasma accelerator 1961 to present; (5) microwave interaction with shock-produced plasmas 1960 to present; (6) plasma–electron-beam interaction studies 1962 to present. Also, a list of major equipment on hand is presented. I.v.L.

N64-21116 Rocketdyne, Canoga Park, Calif.

PERFORMANCE DATA FOR INDIVIDUAL ATLAS MA-2 AND MA-5 ENGINES

J. J. Griffin 28 Feb. 1964 55 p

(Contract AF 04(695)-306)

(R-5108-2; AD-431295)

Accurate information is presented that can be used to calculate flight trajectories for missiles powered by the Atlas MA-2 or MA-5 propulsion systems. The reported values for the engines were determined by averaging acceptance-test values corrected to rated thrust and standard conditions. Tabular information is included in the following: (1) serial numbers and final acceptance-test dates for MA-2 booster and sustainer engines, plus values for engine thrust, mixture ratio, specific impulse, and lox regulator reference pressure; (2) engine and serial numbers and final acceptance-test dates for MA-5 booster and sustainer engines, plus values for thrust, mixture ratio, specific impulse, lox regulator reference pressure, turbopump speed, estimated engine-duration capability; and (3) engine serial numbers and final acceptance-test dates for MA-5 vernier engines, plus the tank-fed and pump-fed injector and chamber pressures to achieve rated thrust and mixture ratio. P.V.E.

N64-21214 Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center

A PARTIALLY ANNOTATED BIBLIOGRAPHY OF REPORTS IN THE FIELD OF SECONDARY INJECTION THRUST VECTOR CONTROL

Walter E. Whitacre, R. W. Miller, and L. M. Hair 7 Feb. 1964 87 p refs

(HREC/LMSC-A033127; TM-54/01-27)

The following are included: (1) a listing of reports and papers directly related to SITVC (Secondary Injection Thrust Vector Control); (2) annotation of the reports listed in (1); (3) a listing of reports and papers on closely related subjects; (4) alphabetical indexes, by author or company of referenced works; (5) an alphabetical listing of other known reports in the TVC (Thrust Vector Control) field; and (6) a listing of other known TVC bibliographies. R.T.K.

N64-21272* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECT OF STAGE SPACING ON PERFORMANCE OF 3.75-INCH-MEAN-DIAMETER TWO-STAGE TURBINE HAVING PARTIAL ADMISSION IN THE FIRST STAGE

William J. Nusbaum and Robert Y. Wong Washington, NASA, Jun. 1964 1964 24 p refs

(NASA-TN-D-2335) OTS: $0.75

The design and the experimental investigation of a 3.75-in.-mean-diameter partial-admission two-stage turbine are presented herein. The investigation was made to determine the effect on two-stage-turbine performance of a change in the axial distance between stages for a turbine with partial admission in the first stage. Accordingly, the turbine was designed with 31.3-percent admission in the first stage, full admission in the second stage, and provision for changing the axial distance between stages. The results of the two-stage investigation are presented for each of the axial distances between stages of 0.25, 0.50, 0.75, 1.00, 1.50, and 2.00 inches. The results of the first-stage investigation are also presented, together with a calculated efficiency for the second stage, at each value of stage spacing as calculated from the two-stage and first-stage results. Author

N64-21409 Kaman Aircraft Corp., Colorado Springs, Colo. Kaman Nuclear Div.

INTERACTION OF ONE-DIMENSIONAL SHOCKS FOR EQUILIBRIUM AIR

Louis E. Bothell and Belmont S. Evans 15 Jan. 1964 24 p refs

(Contract DA-23-072-AMC-55(Z))

(KN-689-64-5; AD-439587)

A collection of charts that may be used for evaluating properties related to the state of air after the interaction of two one-dimensional strong shocks is presented. The equilibrium properties of air in the region of interaction are given. An equation-of-state diagram that relates the properties of "real" air is also included. All the results were obtained by using the thermodynamic functions of air in thermodynamic equilibrium that have been published by the Bureau of Standards, as well as data published by the Academy of Sciences of the U.S.S.R. The ICAO (International Civil Air Organization) Standard Atmosphere data were used for the properties of the free field as a function of altitude. Shock interaction relations and the calculational procedure are also included. R.T.K.

28 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. *For related information see*: 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

N64-20769 Athens Academy (Greece)
EXPRESSION OF SOLAR ACTIVITY AS A FUNCTION OF THE TIME OF RISE [EXPRESSION DE L'ACTIVITE SOLAIRE EN FONCTION DU TEMPS D'ASCENSION]
Jean Xanthakis *In* AGARD Advan. in Upper Atmosphere Res. 1963 p 285–302 refs In FRENCH; ENGLISH summary (See N64-20752 14-12) Pergamon Press: 80s.

An analytical equation is established for the maximum of the solar activity (Wolf numbers and sunspot areas) as functions of the time of rise. The latter is expressed in solar synodic rotations or in months. The maximum of solar activity obeys a parabolic law. In certain cases, the deviations from this law seem not to be fortuitous, but they are periodic functions of a long period. The mean daily values of the areas of sunspots and umbrae are studied for each year from 1879 to 1953 and of the Wolf numbers for the years 1755 to 1953. In this case the analytical representation of the curves of solar activity as a function of the time of rise expressed in years is given. For the areas of the umbrae, a periodic term with a period of 2 solar cycles is also present. The asymmetry N/S of the two hemispheres can be expressed as a function of the time of rise and of a periodic term with a period of 7 solar cycles. Author

N64-21021 Harvard U., Cambridge, Mass.
RESEARCH DIRECTED TOWARD THE INVESTIGATION OF SOLAR PHENOMENA Final Report
Barbara Bell and Donald H. Menzel Feb. 1964
(Contract AF 19(604)-4962)
(AFCRL-64-275; AD-600268)

The research falls into the following major categories: (1) solar-terrestrial correlations, relating geomagnetic disturbance and solar proton (PCA) events to such solar features as the location (north or south of the solar equator) and magnetic class of the flaring sunspot, radio bursts of spectral types II and IV and various properties thereof, and the brightness of the green coronal line; (2) studies of solar prominences, involving both measurement and classification of observed prominences, and theoretical investigation of their structure and of physical processes important in their formation; (3) studies of the rocket ultraviolet solar spectrum, with special attention to the Lyman-α line of hydrogen as a major source of opacity over several hundred angstroms; (4) work on the calculation of theoretical transition probabilities for complex atoms; and (5) studies of other solar features, including the sunspot zone, the positional relation of flares to sunspots, details of the solar disk in the light of Hα, and activity zones in the emission-line corona. Author

N64-21082 Uppsala U. (Sweden) Inst. of Physics
SPECTRAL VARIATIONS DURING COSMIC RAY STORMS Technical Note No. 4
B. O. Gronkvist 20 Mar. 1964 20 p refs
(Contract AF 61(052)-614)
(AFCRL-64-395; AD-600367)

Three cosmic ray storms during the IGY, which differed as to type, were treated for a study of changes in the effective integral rigidity spectrum. The time dependence of the exponent γ of the spectrum is illustrated for the rigidity region 11 to 18 Gv with a time resolution of 2 hours. An analytical expression is given in which changes in the effective integral spectrum are transformed into changes in the primary spectrum. The extreme values of these changes vary from one storm to another. An extension of the treatment to lower rigidities is discussed. Author

N64-21222 California U., Berkeley Space Sciences Lab.
Pi 2'S, A REVIEW
Ruben Zelwer 11 Feb. 1964 50 p refs
(Contract Nonr-222(89))
(Series 5, Issue 7; AD-432848)

Geomagnetic micropulsations are divided into those of regular and continuous character and those with an irregular pattern. This latter group is characterized by close connection with major disturbances of the magnetic field and their correlation with upper-atmospheric phenomena. This group is divided into two subgroups covering different frequency ranges, one of which is the pi 2 (60 to 100 sec) corresponding to the pt's (pulsation trains). The pi 2's show a very strong LMT (Local Mean Time) dependence. In regard to annual distribution, the maximum of their occurrence frequency is in the spring equinox. The pi 2's of a sufficient amplitude can be observed all around the earth. Bays are the most common phenomena associated with pi 2's. Observation has been made of the increase of pi 2 amplitude at times of great ionospheric absorption or at times of cosmic noise. In addition to a discussion of the above data, the report contains a detailed review of selected major theories of the causes of pi 2's. A.W.

N64-21228 Johann Wolfgang Goethe U., Frankfurt am Main (W. Germany) Astronomische Inst.
NORTH-SOUTH ASYMMETRY IN SOLAR WIND AND IN SOLAR SPOTTEDNESS [DIE NORD-SUD-ASYMMETRIE DES SONNENWINDES UND DER SONNENFLECKEN-HAUFIGKEIT]
W. Gleissberg 1964 19 p refs in GERMAN; ENGLISH summary
(Publ.-8)

The north–south asymmetry in solar wind was compared with the north–south asymmetry in solar spottedness for cycles 13 to 19 of solar activity. This north–south asymmetry in solar wind was computed from the average values of geomagnetic activity during the periods when the heliocentric latitude of the earth is above $+5°$ or below $-5°$, respectively. During cycles 13 to 18 the two asymmetries vary in a very similar manner; a systematic preponderance of the Southern Hemisphere in the intensity of the solar wind may be explained as distance effect. The close relation between the two asymmetries ceases in cycle 19. In cycle 19, the asymmetry in solar wind is in better agreement with the phase of the 80-year cycle than the asymmetry in solar spottedness; cycle 19 also shows an anomalous behavior in other respects. Author

N64-21229 Johann Wolfgang Goethe U., Frankfurt am Main (W. Germany) Astronomische Inst.
STATISTICAL DATA ON THE RELIABILITY OF SHORT-TERM SUNSPOT FORECASTS [STATISTISCHE ANGABEN UBER DIE ZUVERLASSIGKEIT KURZFRISTIGER SONNEN-FLECKENPROGNOSEN]
N. Feldmann 1964 14 p refs in GERMAN
(Rept.-6)

A comparison was made between the predicted and the observed number of sunspots from Jan. 1959 through June 1962. The error between the predicted and the observed number was calculated, and the result was used to investigate the reliability of the forecast for successive time periods. P.V.E.

N64-21259* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE EFFECT OF A RING CURRENT ON THE BOUNDARY OF THE GEOMAGNETIC FIELD IN A STEADY SOLAR WIND
John R. Spreiter and Alberta Y. Alksne Washington, NASA, Dec. 1963 45 p refs
(NASA-TR-R-177) OTS: $1.25

Approximate solutions are given for the shape of the boundary separating a steady neutral stream of ionized solar corpuscles from the combined magnetic fields of a three-dimensional dipole and an equatorial ring current. Results are presented for the traces of the boundary in the geomagnetic meridian plane containing the sun–earth line for several orientations of the latter relative to the dipole axis, and for the trace of the boundary in the geomagnetic equatorial plane for the case in which the dipole axis is normal to the sun–earth line. The presence of a ring current having values for the diameter and strength of the order proposed to explain the magnetometer data from Pioneer I and Pioneer V has the effect of greatly increasing the size, as well as altering the form, of the region within which the geomagnetic field is confined. Author

N64-21260* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THEORETICAL DETERMINATION OF THE BOUNDARY AND DISTORTION OF THE GEOMAGNETIC FIELD IN A STEADY SOLAR WIND

Benjamin R. Briggs and John R. Spreiter Washington, NASA, Dec. 1963 19 p refs
(NASA-TR-R-178) OTS: $0.50

An approximate formulation of the steady-state Chapman–Ferraro problem is used to calculate the coordinates of the complete boundary of the geomagnetic field. Field lines are then computed in the magnetic meridian plane containing the free-stream direction of the solar wind, taking into account the distorting effects of currents flowing in the boundary. Numerical results are given for the case where the geomagnetic dipole axis is perpendicular to the direction of the solar wind. Author

N64-21261* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECT OF UNIFORM EXTERNAL PRESSURE AND OBLIQUE INCIDENCE OF THE SOLAR WIND ON THE TERMINAL SHAPE OF THE GEOMAGNETIC FIELD

John R. Spreiter and Audrey L. Summers Washington, NASA, Dec. 1963 36 p refs
(NASA-TR-R-181) OTS: $1.00

Approximate solutions and numerical results are given for the coordinates of the boundary separating the geomagnetic field from the interplanetary plasma for a $\pm 35°$ range of angles between the direction of the incident stream and the geomagnetic equatorial plane for a model that assumes the plasma pressure exerted on the boundary to be composed of two components. One is a dynamic pressure proportional to the normal component of the momentum of the particles of a steady uniform incident stream. The other is a static pressure considered to be constant over the entire boundary, including the shielded portions adjacent to dead-water regions on the downwind side of the earth and near the neutral points. Results are presented for the traces of the boundary in the meridian plane containing the sun–earth line and the dipole axis for a complete range of values for the ratio between the two pressure components. Author

N64-21275* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SOLAR PROTON SPECTRUMS IN THE EVENTS OF NOVEMBER 12 AND 15, 1960

K. W. Ogilvie and D. A. Bryant Repr. from J. Geophys. Res., v. 69, no. 3, 1 Feb. 1964 p 393–398 refs
(NASA-RP-172)

From a series of rocket flights it is found that for the November 12 event an exponential rigidity spectrum does not fit the observations, owing to the presence of a relatively large number of low-energy protons, and that data obtained late in the November 15 event are consistent with an exponential rigidity spectrum. It is suggested that the difference in character of the spectra observed in these two events is due to a flux of low-energy protons arriving at the earth on November 12 with the solar plasma responsible for concurrent geomagnetic disturbances. The flights made late in the November 15 event were during a geomagnetically quiet time. I.A.A.

N64-21281* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

PROTON FLUXES ALONG LOW-ACCELERATION TRAJECTORIES THROUGH THE VAN ALLEN BELT

Frank J. Hrach Repr. from AIAA J., v. 2, no. 4, Apr. 1964 p 762–764 refs
(NASA-RP-193)

Presented as an estimate of the time-integrated flux for trajectories having a constant acceleration in the range of 5×10^{-4} to 10^{-2} miles/sec^2 and an inclination angle between the vehicle orbit plane and the equatorial plane in the range of 0° to 90°. Considered are spatial flux distribution, vehicle trajectory, and calculation procedure; the effect of acceleration is shown. Curves of equivalent hours at the heart of the belt vs acceleration are drawn for inclinations of 0°, 28.4°, 60°, and 90°. An orbit plane of 28.4° would be achieved by launching a rocket due east from Cape Kennedy. I.A.A.

N64-21485 Lockheed-California Co., Burbank

INTERPLANETARY MAGNETIC FIELDS. A BIBLIOGRAPHY OF THE OPEN LITERATURE, JANUARY 1958-APRIL 1964

John P. Lathourakis, comp., May 1964 44 p refs
(LR-17860)

This unannotated bibliography comprises a search of the recent unclassified literature on interplanetary magnetic fields. The citations provided refer to direct and indirect observations; theoretical work was not considered. References to interactive forces and the earth's magnetosphere are not complete and are treated in separate sections. Author

29 SPACE SCIENCES

Includes space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories. *For space biology see*: 16 Life Sciences. *For related information see*: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N64-20812* General Motors Corp., Santa Barbara, Calif. Defense Research Labs.

LUNAR SOIL PROPERTIES MEASURING DEVICE ASSOCIATED TEST EQUIPMENT — OPERATION AND MAINTENANCE

Nov. 1962 49 p Prepared for JPL
(Contract NAS7-100)
(NASA-CR-56174; OM-62-201) OTS: $4.60 ph

The lunar soil properties measuring device (LSPMD) provides information about the traction and load-bearing properties of lunar soil by measuring the force developed against pads deployed into the ground. The LSPMD, which operates from a fixed position, has three probing units terminated as follows: a 2-in.-diam pad, a 4-in.-diam pad, and a rotating shear. Deployment is accomplished by a motor that drives all three units down until the deployment sensor reaches the soil. The test console supplies operating voltages for the LSPMD

and monitors outputs from the strain gages and potentiometers. The test fixture provides a mechanical load for the LSPMD by a system of springs. The force exerted by the spring is a function of the distance; it is compressed by an LSPMD pad and is sensed by the load cells in the LSPMD and in the test fixture. The load cell signals are simultaneously recorded by the oscillograph in the console. A circuit analysis of the system is presented to assist in troubleshooting. I.v.L.

N64-20818* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

UNIFIED GUIDANCE ANALYSIS IN DESIGN OF SPACE TRAJECTORIES

T. T. Soong, C. G. Pfeiffer, and R. Hamburg 31 Jan. 1964 25 p refs

(Contract NAS7-100)

(NASA CR-56169; JPL-TR-32-577) OTS: $2.60 ph

Based on the fact that all ballistic space trajectories can be approximated by individual conic sections, certain geometric and dynamic similarities of these trajectories permit a systematic and unified guidance investigation. A set of dimensionless differential corrections is developed, and a "proper" coordinate system suitable for generalized guidance analysis is given. Numerical results in graphic form are presented applicable to the calculation of target dispersions due to random injection errors and determination of required midcourse corrective maneuvers. Author

N64-20898* Pittsburgh U., Pa.

SOURCE OF EVOLUTION OF GAS FROM THE LUNAR CRATER ALPHONSUS

Alvin J. Cohen Repr. from Nature, v. 201, no. 4923, 7 Mar. 1964 p 1015–1016 refs

(Grant NsG-416)

Plausible mechanisms to account for the gas issuing periodically from Alphonsus are discussed. There is a possibility that the gas was injected into brecciated shock-faulted areas in the craters of Alphonsus during their creation, if produced by impact of cometary matter, and that slow outgassing is taking place. However, it is more probable that Kozyrev observed outgassing from the major fault bisecting Alphonsus, and that the gas has its source deep within the Moon's surface where it is slowly being ejected as a result of radioactive heating. I.v.L.

N64-20899* New Mexico State U., University Park

OBSERVATIONS OF THE OPTICALLY THIN SCATTERING LAYER IN THE ATMOSPHERE OF VENUS

Bradford A. Smith and Walter E. Bains Repr. from Astron. J., v. 69, no. 2, Mar. 1964 1 p refs

(Grant NsG-142-61)

Photographic observations were made during the inferior conjunctions of 1959, 1961, and 1962. In addition to confirming the existence of an optically thin scattering layer overlying an opaque surface on Venus, established through observations of cusp extensions near the inferior conjunction, and establishing that the extension angles of the two cusps are usually asymmetric, the photographs indicate the probable existence of very weak scattering at heights as great as 30 to 40 km above the opaque surface. A composite of heights published by Edson and those obtained by the authors (at elongation angles less than 10°) suggests a symmetry about an axis nearly perpendicular to the orbital plane. Symmetry about any axis other than the orbital radius vector can be produced only by rotation. These observations tend to conflict with the current concept of synchronous rotation of Venus. I.v.L.

N64-20954* Analytical Mechanics Associates, Inc., Uniondale, N.Y.

CONSTANTS OF THE MOTION FOR OPTIMUM THRUST TRAJECTORIES IN A CENTRAL FORCE FIELD

Samuel Pines 1 Oct. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 97–116A refs (See N64-20949 14-01)

(Contract NAS8-5314)

This paper derived four constants of the motion for optimal thrust trajectories in a central force field. Two additional constants of the motion are derived that hold for singular thrusting arcs as well as impulsive thrusts. The paper applies the constants of the motion for the impulsive thrust case, to obtain a set of initial conditions for the classical adjoint variables to be used as a good approximation for a solution of the finite thrust arc by the indirect method. Author

N64-20955* General Electric Co., Philadelphia, Pa. Space Sciences Lab.

OPTIMUM RETRO-THRUST IN A GRAVITATIONAL FIELD

Carlos R. Cavoti 30 Aug. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 117–143 refs (See N64-20949 14-01)

(Contract NAS8-11040)

(Rept.-1)

The planar motion of a mass-point vehicle subject to the inverse-square central gravitational attraction of a spherical planet and to a tangential retrothrust force is considered. It is shown that for minimum fuel consumption (free-time, free-range) problems, the control variable (mass-flow rate of the engine) may be obtained explicitly along the intermediate retrothrust subarcs in terms of the state variables of the problem. The variable retrothrust subarcs are shown to be integrable in closed form and thus completely determined, except for three constants of integration. The variable retrothrust subarcs are such that the magnitude of the vector velocity is constant along them. Author

N64-20956* North American Aviation, Inc., Downey, Calif. Space Sciences Lab.

ON A RESTRICTED COMPARISON OF TWO IMPULSE AND ONE IMPULSE ORBITAL TRANSFER

Gentry Lee 8 Aug. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 145–154 refs (See N64-20949 14-01)

(Contract NAS8-5211)

(Spec. Rept.-4)

The comparison of one- and two-impulse orbital transfers, basic to the solution of the optimum n-impulse problem, is extended to include all copolar elliptical orbits of equal angular momentum. Familiar vector expressions are used to identify, for all cases, a specific family of two-impulse transfers that require no more total impulse than the one-impulse transfer applied at the intersection. Author

N64-20957* North American Aviation, Inc., Downey, Calif. Space Sciences Lab.

A COMPARISON OF ONE AND TWO IMPULSE TRANSFER FOR NEARLY TANGENT COPLANAR ELLIPTICAL ORBITS

D. F. Bender 16 Dec. 1963 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 155–172 refs (See N64-20949 14-01)
(Contract NAS8-5211)
(Spec. Rept.-5)

It is proved, given two elliptic orbits that are tangent at a point not an apsis, and given that a pair of nearby intersections is obtained by sufficiently small variations of the elements (from the tangent condition), that the impulse for transfer at one of the intersections will be less than that for transfer at tangency. For the case that the intersections are caused and deepened by changing only the relative orientation, numerical results show the one impulse transfer to pass through a minimum. On the same graph there is also plotted the impulse for optimum two-impulse transfer, and it is seen that near the one impulse minimum there is a region where one- and two-impulse transfers require the same impulse to two parts in 10^5 for the moderately eccentric cases chosen. Author

N64-20963* Minneapolis-Honeywell Regulator Co., Minn. Military Products Group
A LYAPUNOV TECHNIQUE FOR OBTAINING EXTENSIONS OF AN OPEN LOOP CONTROL TO A NEIGHBORHOOD OF THE OPEN LOOP TRAJECTORY
D. L. Lukes *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 267–279 (See N64-20949 14-01)

It is assumed that a reference trajectory and the corresponding control function have been determined for a given dynamical system. The problem posed is the extension of the control to a neighborhood of the reference trajectory to obtain a feedback control that drives the system to the given final state. The technique is based on the construction of a Lyapunov function defined in some neighborhood of the reference trajectory. The Lyapunov technique presented differs from the classical technique in that it does not require a linearization of the system equations; stability is insured. R.T.K.

N64-20965* Aeronutronic, Newport Beach, Calif.
PERTURBATION SOLUTIONS FOR LOW THRUST ROCKET TRAJECTORIES
D. P. Johnson and L. W. Stumpf 10 Jan. 1964 *In* NASA. Marshall Space Flight Center Studies in the Fields of Space Flight and Guidance Theory 17 Mar. 1964 p 305–322 refs (See N64-20949 14-01)
(Contract NAS8-5248)

Perturbation solutions of the equations of motion are presented that define the motion of a vehicle subjected to a low, constant thrust acceleration. A complete second-order solution is given for the case in which the thrust vector makes an arbitrary but constant angle with the radius vector. Application of the theory to transfers between circular orbits is discussed. Author

N64-21085 Aerospace Corp., El Segundo, Calif. System Research Planning Div.
ERROR DERIVATIVES FOR ELLIPTIC ORBITS
E. R. Lancaster 26 Feb. 1964 32 p
(Contract AF 04(695)-269)
(SSD-TDR-63-255; TDR-269(4550-10)-2; AD-600458)

When an increment of velocity is applied to an orbiting vehicle in an attempt to bring it to earth, errors will exist in the assumed position and velocity of the vehicle and in the applied velocity increment. If these errors are sufficiently small, a linear error analysis is sufficient for determining their effects on quantities of interest at later times such as impact point coordinates. Formulas were derived in this report for the partial derivatives required for such an error analysis, assuming a nonrotating, spherical earth with no atmosphere. Author

N64-21248 Naval Ordnance Lab., White Oak, Md.
POINT-MASS TRAJECTORY DATA FOR MANEUVERABLE BALLISTIC MISSILE RE-ENTRY VEHICLES Aerodynamics Research Report No. 205
Lawrence T. Brekka Feb. 1964 144 p refs
(NOLTR-63-193)

A digital program was used to compute the point-mass trajectories of maneuverable ballistic missile reentry vehicles. Lift–drag ratios from −2 to +2 and ballistic coefficients from 100 to 3,000 lb/ft^2 were examined. Reentry velocities were varied from 5,000 to 25,000 ft/sec, reentry angles from −15° to −55° and bank angles from 0° to 180°. Three cases were compiled: (1) The lift and the bank angle remained constant from reentry to ground impact. (2) The lift was applied with a given bank angle at some selected altitude after a zero lift reentry. (3) The skipping caused by positive lift in three of the second runs was controlled by applying negative lift at a final control point. For the second and third, the ballistic coefficient was set at 1,000 lb/ft^2 and the reentry angle at −35°. In all three cases the aerodynamic coefficients were assumed to be constant. Maximum load factors, range, time of flight, and impact velocity were obtained from every trajectory. Neither heating nor ablation was considered. Skip characteristics from the second and third cases and the impact angles from the third case were compiled. The complete results of the project are summarized in a series of curves. Author

N64-21258* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
ON ENERGY-OPTIMAL TRAJECTORIES IN THREE DIMENSIONS FOR THE TERMINAL PHASE OF SATELLITE RENDEZVOUS
Terrance M. Carney Washington, NASA, Dec. 1963 46 p refs
(NASA-TR-R-175) OTS: $1.25

A solution to the problem of finding the energy-optimal trajectory for terminal rendezvous with a satellite station in circular orbit by using the classical calculus of variations is described. A terminal-stage engine with constant thrust and fixed burning time is specified, and both the optimal initial conditions and thrust orientation time history are determined by the criterion that the energy gain be maximized. The problem is formulated in three dimensions, with the constraint that the terminal stage must turn through a prescribed initial angle between the target orbital plane and the rendezvous-vehicle velocity vector. Numerical solutions to the two-point boundary-value problem were generated by using an adjoint iteration technique. Near-earth orbital rendezvous trajectories were calculated for orbital altitudes of 100, 200, and 500 nmi, initial thrust-to-mass ratios of 0.25g and 1g, and burning times of 100 and 200 sec. Author

N64-21276* National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.
THE PLANET JUPITER
Rupert Wildt (Yale U.), Harlan J. Smith (Yale U.), Edwin E. Salpeter (Cornell U.), and A. G. W. Cameron Repr. from Phys. Today, v. 16, no. 5, May 1963 p 19–23
(NASA-RP-173)

What is known about Jupiter and what is merely speculated about it are summarized. Much discussion is generated about the interferometric observations on decimeter radiation, as made by groups from the California Institute of Technology. The suggestion is made that previous models of Jupiter's atmosphere are incorrect because they neglect changes

produced by the condensation of ammonia and water vapor on the structure of the atmosphere. There is general agreement that the bulk structure of Jupiter is different from that of a cold planet. A rational explanation of the Great Red Spot, in terms of hydrodynamics, is provided for the first time by a general picture of the surface of Jupiter. A.W.

N64-21372* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE DYNAMICS OF RETRIEVAL OF TETHERED ASTRONAUTS
Gary P. Beasley, Roy F. Brissenden, Warren H. Straly, and Robert W. Adlhoch (Marquardt Corp.) N.Y., AIAA, [1964] 19 p refs Presented at the First AIAA Ann. Meeting, Washington, 29 Jun.–2 Jul. 1964
(AIAA-Paper-64-292) AIAA: $0.50 members, $1.00 nonmembers

The astronaut operational envelope defines the magnitude of the retrieval problem. The primary consideration is the angular momentum of the orbiting system. The requirements for the implementation of a mechanical system for routine or emergency retrieval operations are discussed. It is shown that constant tension techniques do not lend themselves to efficient retrieval. However, various techniques for judicious use of line tension can be used successfully to allow partial reel-in and circularization of the tethered mass for retention and capture. A system that provides momentum dissipation during retrieval is the most satisfactory, and the one that uses thrust applied at the smaller mass is the more efficient. Author

N64-21407 RAND Corp., Santa Monica, Calif.
THE ERROR IN ESTIMATING MISSILE POSITION AND VELOCITY AT CUTOFF FROM SMOOTHED DATA
William B. Kendall Dec. 1963 10 p refs
(Supported by ARPA)
(P-2796)

The theory of least-mean-squared error curve fitting is used to derive expressions for the accuracy with which the cutoff position and velocity of a ballistic missile can be estimated from noisy measurements. The correlation between the estimates is determined. These results are then specialized to the estimation of angular position and velocity from measurements made with an infrared tracker. Numerical examples for two possible trackers are presented. Author

N64-21429* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF GUIDANCE TO REFERENCE TRAJECTORIES FOR LIFTING REENTRY AT SUPERCIRCULAR VELOCITY
Rodney C. Wingrove Washington, NASA, Dec. 1963 66 p refs
(NASA-TR-R-151) OTS: $1.75

This report presents an analysis of the guidance of lifting vehicles onto a reference trajectory during atmosphere entry. Various reference trajectories and various input quantities to govern lift variations were considered. A guidance method was developed using the four-state variables of a trajectory. Velocity was made the independent variable, and the errors in the rate of climb, acceleration, and range relative to the reference govern the lift. A linearized form of the motion equations was used to show that this method represents a third-order control system. First- and second-order terms determined the entry corridor depth by stabilizing the trajectory so that the vehicle does not skip out of the atmosphere or does not exceed a specified acceleration limit. The destabilizing effect that range input can have is illustrated, and the results indicated that a low value of range input gain must be used at the high supercircular velocities while larger values can be used at lower velocities. Author

30 SPACE VEHICLES

Includes launch vehicle-spacecraft combinations; missile systems; operating problems; safety devices; and stability and control. *For boosters and launch vehicles see*: 31 Space Vehicles (Launch Vehicles). *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N64-20994 Picatinny Arsenal, Dover, N.J.
MISSILE FAILURE DUE TO IMPURITIES IN ELECTROPLATES
Paul Mahler *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 467–475 refs (See N64-20967 14-09)

The VUT is well suited for the removal of absorbates. Defects in plating become easily detectable, and loosely adhering plating is knocked off when electroplates are subjected to the VUT. Rinsing merely removes the surface-adhering film of electrolyte. Soldered joints on electroplated surfaces free from absorbate should be stronger and more reliable. Using the VUT will benefit electroplaters because: (1) Customer complaints because of discoloration of plating would practically be eliminated. (2) Fewer parts with defective platings would be shipped. (3) It gives electroplaters the capability of making reliable components for special weapon, test equipment, space satellite, and spacecraft applications. Author

N64-21032 Picatinny Arsenal, Dover, N.J. Engineering Sciences Lab.
RESEARCH FOR DETERMINATION OF BLAST EFFECTS ON RE-ENTRY VEHICLE STRUCTURES Status Report
Lawrence Rosendorf and Irving Kintish Mar. 1963 37 p refs
(Contract AF 33(657)-2-R&D-233)
(TM-1152; AD-400134)

This report outlines the experimental work performed to derive, by model testing, analytical and experimental techniques for the determination of blast loading and target response of ballistic missile reentry structures. This information is considered a prerequisite in determining the kill and vulnerability of such targets to nuclear attack. Simple shell structures of varying geometric parameters have been instrumented with pressure transducers and strain gages and subjected to airblast from varying high explosive charge weights. A preliminary analytical approach to predict the incipient buckling pressure of the targets (cylindrical portion only) has been developed. This approach is based on a "dynamic load factor" that enables computation of the dynamic buckling pressure from the static formulations. Plans are discussed for multiton high explosive tests. Author

N64-21033 Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.
DESIGN OF HYDROGEN-OXYGEN CAPILLARY TYPE FUEL CELL Second Quarterly Technical Progress Report, 1 Feb. 1963-30 Apr. 1964
J. C. Prestridge, ed. 15 May 1964 22 p
(Contract AF 33(615)-1185)
(AD-439670)

Performance startup condition, and qualification testing of the static orbital package were completed. A package has been installed on the launch vehicle panel and has undergone

vehicle system motion tests. Work on the 28-volt system is progressing, and preliminary design studies and testing are being conducted. Author

N64-21090 Frankford Arsenal, Philadelphia, Pa.
DESCRIPTION OF ROCKET CATAPULTS XM26, XM27, AND XM28
N. J. Waecker May 1964 11 p
(M64-27-1; AD-440352)

The design and construction of the XM26, XM27, and XM28 dirigible (steerable) rocket-assisted catapult units are presented, including a comparison of pertinent physical dimensions and output. Installation and overall operation of the units are described. Operation of the dirigible nozzle and its control features are explained. Author

N64-21253* Minneapolis-Honeywell Regulator Co., Minn.
ROCKET BOOSTER CONTROL. A SUFFICIENT CONDITION IN OPTIMAL CONTROL
E. B. Lee Washington, NASA, May 1964 11 p refs
(Contract NASw-563)
(NASA-CR-50)

A theorem is proven that covers most of the known cases where L. S. Pontryagin's maximum principle is a sufficient, as well as a necessary, condition for optimal control. Author

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes boosters; clustered rockets; and multistage rockets. *For propulsion engines see*: 27 Propulsion. *For manned space capsules, satellites, and sounding rockets and space probes see*: 32 Space Vehicles (Spacecraft). *For launch vehicle-spacecraft combinations see*: 30 Space Vehicles. *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

No abstracts in this issue.

32 SPACE VEHICLES (SPACECRAFT)

Includes manned space capsules; satellites; and sounding rockets and space probes. *For boosters and launch vehicles see*: 31 Space Vehicles (Launch Vehicles). *For launch vehicle-spacecraft combinations see*: 30 Space Vehicles. *For related information see*: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N64-21181 Naval Ordnance Lab., White Oak, Md.
HASP, INSTRUMENTED, RELEASE TO PROTOTYPE PRODUCTION FOR EVALUATION OF THE HEADS, 1.625-INCH, ROCKET, MK I MOD O AND MK 2 MOD O
M. J. Parker Apr. 1964 69 p
(NOLTR-63-272; AD-433567)

The development history is presented of the instrumented High Altitude Sounding Projectile (HASP) that senses atmospheric temperature and winds to 150,000-feet altitude. The following are discussed in particular: flight-test program, electronic circuitry, environmental-test program, and performance of radiosonde set WOX-1A. P.V.E.

N64-21240 ITT Federal Labs., San Fernando, Calif.
RESEARCH ON THE DETECTION OF INFRARED EMISSION FROM SATELLITE VEHICLES Final Report
F. F. Hall, Jr. Feb. 1964 18 p refs
(Contract AF 19(604)-4971)
(AFCRL-64-302; AD-438723)

Satellite irradiance measurements were influenced by the variable atmospheric background radiance, especially during twilight hours. Measurements of the 0.7 to 3.0 μ radiance of the atmosphere during twilight were made as a function of time and zenith angle. This enabled the calculation of scattering diagrams for aerosols in the upper atmosphere. Particles near the tropopause scatter predominantly in the forward direction, typical of dielectric spheres. Particles near 32 km scatter in the backward direction, as do conductive spheres. The data interpretation is not influenced by nonconservative scattering; this may be expected due to water absorption bands in the aerosols in the near infrared region. Author

N64-21265* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE DETERMINATION FOR TIROS SATELLITES
Joseph W. Siry and Joseph V. Natrella (NASA Headquarters)
Washington, NASA, Jun. 1964 18 p
(NASA-TN-D-2143) OTS: $0.50

The Tiros satellites scan the earth's cloud cover by means of television, and observe its infrared albedo in several wavelength regions. The satellite is spin stabilized, but the spin axis direction varies in response to magnetic and gravitational torques. The recent Tiros satellites contain a variable intensity electromagnet to steer the satellite in orbit; and the satellite's attitude must be determined and predicted so that appropriate steering commands can be given. The basic data for determining the satellite attitude are obtained from the television pictures and from the infrared sensors themselves (the latter sense horizon transit times). These basic data are processed, edited, and analyzed, together with accurate orbital information, by means of attitude and orbit determination systems formulated and programed for use in IBM-7094 computers. The pointing directions for the various cameras and sensors are determined, predicted, and programed by means of these attitude determination systems. Author

N64-21352* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FULL-SCALE GEMINI-AGENA DOCKING USING FIXED- AND MOVING BASE SIMULATORS
Howard G. Hatch, Jr., Donald R. Riley, and Jere B. Cobb N.Y., AIAA [1963] 21 p refs Presented at the First AIAA Ann. Meeting, Washington, 29 Jun.–2 Jul. 1964
(AIAA Paper-64-334) AIAA: $0.50 members; $1.00 nonmembers

Full-scale simulations of the docking of the Gemini spacecraft and orbiting Agena target have been completed using both fixed- and moving-base simulators. Results obtained by using both simulations are presented for: pilot ability to dock successfully, piloting techniques, and performance with the pilot using only visual observation of the Agena target for guidance information. Both rate command (primary) and acceleration command (backup) modes for attitude control were investigated, as well as the effects of control-jet malfunctions and target lighting conditions. I.v.L.

N64-21431* National Aeronautics and Space Administration, Washington, D.C.
METEOROLOGICAL SATELLITES

K. Ya. Kondrat'yev May 1964 290 p refs Transl. into ENGLISH from the book "Meteorologicheskiya Sputniki" Leningrad, Hydrometeorological Publ. House, 1963
(NASA-TT-F-177) OTS: $4.00

This study is concerned with the present state and the future prospects of satellites as an aid to meteorological studies. A detailed account is given of meteorological satellite instrumentation, and results of studies of cloud formation, using photographs obtained by satellites. A considerable amount of space is devoted to the problem of radiation balance in the free atmosphere and the analysis of the corresponding satellite data. A detailed analysis is also given of the future possibilities of experiments concerned with the radiation flux of the earth as a planet, and to the development of optical methods of studying the composition and the structure of the atmosphere. Author

N64-21445 Bendix Corp., Baltimore, Md. Friez Instrument Div.
AIR LAUNCHED ROCKETSOUNDING STUDY Final Report
C. P. Blackburn and D. B. George Apr. 1964 151 p refs
(Contract AF 19(628)-3264)
(AFCRL-64-127; AD-600400)

The results of a program to study, evaluate and recommend the most feasible techniques and equipment for an air launched rocket sounding system compatible with the AN/AMQ-19 meteorological system are presented. The sounding vehicle will be dropped from the aircraft, parachute stabilized, and sequence fired to attain the desired 120,000 ft level. At apogee, the instrument package will separate from the vehicle and transmit pressure, temperature, and humidity data. A control pressure capsule within the sonde will terminate the RF signal when it has descended to aircraft flight level. The vertical profile may be continued to ground level with an AN/AMT-13 radiosonde that is an integral part of the AN/AMQ-19 system. Density of the air through which the sonde passes may be calculated by use of the temperature, pressure, and altitude data obtained for the 120,000 and 250,000 ft systems, since air may be considered as having a constant molecular weight at these altitudes. Functional descriptions of the AN/AMQ-19 and AN/GMH-4 systems have been included in this report, along with a description of the compatibility of the rocketsounding system. Author

N64-21490 Aberdeen Proving Ground, Md. Ballistic Research Labs.
OPERATION ARGUS. CALIBRATION OF EXPLORER IV PROTOTYPE
E. O. Baicy Washington, DASA, 21 Oct. 1963 77 p refs
(WT-1671; AD-431935)

Detailed calibration curves were determined for a prototype Explorer IV radiation-measuring satellite in accordance with a prior mathematical analysis. This analysis demonstrated the necessity for calibration of the complete package in a well prescribed manner if the maximum amount of information was to be obtained from the transmitted data. Previous data analysis had been limited to consideration of average count rates because of limited information about the angular response of the detectors. Since it was of primary interest to obtain mirror point distributions of the trapped electrons in the earth's magnetic field, emphasis was placed on the determination of the directional characteristics of the detectors. The package was calibrated with gamma rays, X-rays, and electrons over both azimuthal and inclination angles. Author

33 STRESSES AND LOADS

Includes fatigue; vibration; flutter; and structural tests. *For thermal stress see*: 13 Heat Transfer and Thermodynamics. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 34 Structural Design.

N64-20773 Syracuse U. Research Inst., N.Y.
COMPLEMENTARY ENERGY METHOD FOR STRUCTURES WITH FINITE DEFORMATIONS
Charles Libove Sep. 1963 75 p refs
(Grant NSF G-14645)
(ME836-639)

A principle of stationary complementary energy is developed for statically loaded structures with finite displacements, rotations and strains, made of material with linear or nonlinear elasticity. The principle is based on a vectorial definition of complementary work analogous to the vectorial definition of ordinary work, and a definition of complementary energy in terms of complementary work analogous to the definition of strain energy in terms of ordinary work. The principle is used to solve several illustrative truss and beam problems. It is shown to include the stationary complementary energy theorem for infinitesimal deformations as a special case. When applied to the buckling of linearly elastic columns it leads to a generalization of Timoshenko's variant of the energy method, in which the strain energy is evaluated from bending moments rather than curvatures. Author

N64-20774 Syracuse U. Research Inst., N.Y.
A COMPLEMENTARY ENERGY THEOREM FOR AXIALLY SYMMETRIC SHELLS WITH LARGE DEFORMATIONS
Charles Libove Oct. 1963 51 p refs
(Grant NSF-G-14645)
(ME836-6310)

A variational theorem is presented for the stresses and meridional slopes in rotationally symmetric shells with large strains, displacements, and slope changes, made of material having linear or nonlinear elasticity. This theorem represents a generalization of the stationary complementary energy theorem for infinitesimal deformations. Author

N64-20866 Gt. Brit. Ministry of Aviation, Mottingham Technical Information and Library Services
TEMPERATURE STRESSES IN A THICK-WALLED CYLINDER WITH LONGITUDINAL VARIATION OF THE MODULUS OF ELASTICITY [TEMPERATURNI NAPRUZHENNYA V TOVSTOSTINNOMU TSILINDRI PRI ZMINI MODULYA PRUZHNOSTI VZDOVZH IOGO TVIRNOI]
Yu. M. Schevchenko May 1964 12 p refs Transl. into ENGLISH from Prikl. Mekh. (Ukr. SSR), v. 4, no. 4, 1958 p 401-410
(TIL/T.5391)

A long isotropic cylinder in an axisymmetric temperature field is considered. The analysis used dimensionless cylindrical coordinates, and the modulus of elasticity is assumed to be an exponential function. Graphical results show that in the case of variable modulus of elasticity the axial internal and external tension 19% less than with constant modulus of elasticity. The external circumferential tension is 30% less. Author

N64-20875 European Atomic Energy Community, Brussels (Belgium)
STUDY OF THE PLASTIC DEFORMATION MECHANISMS OF SAP [CONTRIBUTION A L'ETUDE DE LA PLASTICITE DU SAP]
P. Guyot Joint Nucl. Res. Center, ISPRA estab. (Italy) Feb. 1964 27 p refs In FRENCH; ENGLISH summary Presented at the Journées Mét. D'Automne, Paris, 14–18 Oct. 1963 (EUR-550.f) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

The fundamental plastic deformation mechanisms in the composite material aluminum-alumina were studied. The activation energy and activation volume were determined from room temperature to 600° C. On the basis of results obtained, different hypotheses were proposed: the dislocations were moving by cross-slip and climb until 300° to 350°C; for the higher temperatures, a pinning-unpinning process of dislocations by the alumina particles was started; a theoretical model was made. Author

N64-20938 Advisory Group for Aeronautical Research and Development, Paris (France)
MATRIX METHODS OF STRUCTURAL ANALYSIS
B. Fraeijs de Veubeke ed. (Univ. of Liège and Louvain) Oxford, N.Y., Pergamon Press, 1964 346 p refs Papers Presented at the AGARD Structures and Mater. Panel, Aachen, Sep. 1959 (AGARDOGRAPH-72) Available from Pergamon Press: £5

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2. UPPER AND LOWER BOUNDS IN MATRIX STRUCTURAL ANALYSIS B. M. Fraeijs de Veubeke (Univ. Liège and Louvain) p 165–201 (See N64-20940 14-20)
3. FURTHER DEVELOPMENT AND APPLICATIONS OF THE STIFFNESS METHOD M. J. Turner, H. C. Martin (Washington U.), and R. C. Weikel (Boeing Co.) p 203–266 refs (See N64-13045 04-34)
4. SOME PROBLEMS IN THE DISCRETE ELEMENT REPRESENTATION OF AIRCRAFT STRUCTURES I. C. Taig and R. I. Kerr (Eng. Elec. Aviation, Ltd.) p 267–315 refs (See N64-20941 14-33)
5. DIGITAL ANALYSIS OF NON-LINEAR STRUCTURES BY THE FORCE METHOD P. H. Denke (Douglas Aircraft Co.) p 317–342 refs (See N64-20942 14-33)

N64-20941 English Electric Aviation, Ltd., Warton (Gt. Brit.)
SOME PROBLEMS IN THE DISCRETE ELEMENT REPRESENTATION OF AIRCRAFT STRUCTURES
I. C. Taig and R. I. Kerr *In* AGARD Matrix Methods of Structural Analysis 1964 p 267–315 refs (See N64-20938 14-33) Pergamon Press: £5

A review is given of a number of problems encountered when idealizing complex aircraft structures into discrete elements for the purpose of matrix stress analysis. The first part is concerned with the problems arising in the analysis of wing-type structures by the matrix displacement method, and a number of general topics are also covered. The second part deals with a different set of problems that have been encountered in analyzing fuselage structures by the matrix force method. Author

N64-20942 Douglas Aircraft Co., Inc., Long Beach, Calif.
DIGITAL ANALYSIS OF NON-LINEAR STRUCTURES BY THE FORCE METHOD
Paul H. Denke *In* AGARD Matrix Methods of Structural Analysis 1964 p 317–342 refs (See N64-20938 14-33) Pergamon Press: £5

Current linear and nonlinear problems in the field of digital structural analysis are considered, and the extension of the Douglas Force Method to provide solutions to the nonlinear problems is presented. The idealization of structures utilizing rectangular and nonrectangular gridworks is discussed. Basic equations for the geometric large deflection problem are derived, and some applications are presented. The small deflection stability problem is considered, and the solution to a problem involving the buckling of a stiffened plate is presented. A method of solution to the structual plasticity problem, based on the Prandtl–Reuss plasticity equations, is described. The creep problem is briefly considered, and some results relative to the calculations of natural modes and frequencies for low-aspect-ratio wings are presented. Author

N64-20972 Radio Corp. of America, Camden, N.J. Defense Electronic Products
STRESS-STRENGTH THEORY AND ITS TRANSFORMATION INTO RELIABILITY FUNCTIONS
B. Tiger and K. Weir *In* RADC Phys. of Failure in Electron., vol. 2 [1963] p 94–101 refs (See N64-20967 14-09)

Stress strength refers to the concept of achieving reliability through the use of safety or of derating factors. An item cannot fail until an applied stress exceeds the inherent strength. This paper provides a mathematical means of translating the probability of stress exceeding strength into a more common reliability function, i.e., the probability of survival for a given operating time. Some of the advantages of a test-to-failure program and factorially designed experiments (such as are described in the paper) are: maximum information for a given sample size; simplicity of use and analysis; determination, independently, of the effect of each variable; and determination of the effect of one environment upon the others. This material is applicable to any type of device—electrical, mechanical, or other. A.W.

N64-21110 Martin Co., Denver, Colo.
ACOUSTIC AND RANDOM VIBRATION FATIGUE REPORT
J. Newgent May 1964 5 p refs
(Contract AF 04(695)-150)
(SSD-CR-64-95; AD-600418)

A discussion is presented showing the tests that led to the procedures for design of structural skin panels to withstand the Titan III acoustic environment. The Titan III panels are similar in size and thickness to panels used on Titan I and Titan II. These panels were subjected to higher acoustic levels on the Titan I and Titan II acoustic test program than they will experience on Titan III flights. Therefore, Titan III panels are considered structurally adequate for acoustic environment. Author

N64-21294 Brown U., Providence, R.I. Div. of Applied Mathematics
A NOTE ON THE MECHANICAL CONSTITUTIVE EQUATIONS FOR MATERIALS WITH MEMORY Technical Report No. 91
R. S. Rivlin Mar. 1964 10 p refs
(Rept.-562(10)/91; AD-439265)

Discussed are the restrictions on the mechanical constitutive equations for a material with memory that are due to the fact that simultaneous rotation of the body and reference system leaves the stress unaltered. Two earlier methods of obtaining these restrictions are unified. Author

N64-21304* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
ACOUSTIC DETECTION OF CRACK INITIATION IN SHARPLY NOTCHED SPECIMENS
Melvin H. Jones and William F. Brown, Jr., Repr. from Mater. Res. and Standards, v. 4, no. 3, 1964 p 120–129
(NASA-RP-180)

Of the several techniques employed for pop-in load determination, acoustic detection appears to offer the greatest flexibility under a wide variety of testing conditions. This paper describes an acoustic system that uses an ordinary phonograph pickup and a tape recorder. Both sound and load are recorded on the tape. Results obtained with this technique are described for tests on several sheet alloys, using different specimen types provided with both sharp machined notches and fatigue cracks. In addition, acoustic pop-in data for 7075-T6 aluminum alloy are compared with data obtained with a compliance gage. I.v.L.

N64-21438 Northrop Corp., Hawthorne, Calif. Northrop Norair
INVESTIGATION OF A METHOD FOR THE PREDICTION OF VIBRATORY RESPONSE AND STRESS IN TYPICAL FLIGHT VEHICLE STRUCTURE. SUPPLEMENT I: DYNAMIC MODELING OF COMPLEX STRUCTURES Technical Documentary Report, Dec. 1962–Aug. 1963
W. H. Roberts and P. E. Finwall Wright-Patterson AFB, Ohio, ASD, Apr. 1964 267 p refs
(Contract AF 33(657)-10075)
(NOR-63-139; ASD-TDR-62-801, Suppl. 1; AD-600234)

The primary purpose of this effort was to continue investigations on the feasibility of predicting the vibratory response and stress of a complex vehicle structure by dynamic tests of an improved quarter-scale model. Tests substantiate that this model approach is a useful tool. Pitfalls are discussed. Local and remote acceptance, transmission through structure and to substructure (which are all three-dimensional phenomena), and randomness are a few of the complexities involved. The timeliness and importance of the study are due to its concern with structural integrity and reliability. The dynamically similar structural model must be validated for its high-frequency capability to simulate sandwich and other complex structures. In addition to the obvious necessity for correct simulation of mass, damping, and stiffness, principal factors in the simulation process are end fixity, other boundary conditions, and accurate correlation of the host of compromises that occur in simulating the real structure. Author

N64-21440 Boeing Co., Seattle, Wash. Aero-Space Div.
AN INVESTIGATION OF LOW-CYCLE FATIGUE FAILURES USING APPLIED FRACTURE MECHANICS Technical Documentary Report, 15 Feb. 1963–15 Feb. 1964
C. F. Tiffany and P. M. Lorenz Wright-Patterson AFB, Ohio, AF Mater. Lab., May 1964 109 p refs
(Contract AF 33(657)-10251)
(D2-23141; ML-TDR-64-53; AD-600375)

Basic principles of fracture mechanics were applied to the investigation of cyclic flaw growth characteristics of Ladish D6A-C steel, tested at room temperature; 6Al-4V titanium, tested at −320° F; and 18Ni(300) maraging steel, tested at room temperature using uniaxially loaded, preflawed (fatigue cracked) test specimens. Applicability of such data to prediction of the cyclic life span of biaxially loaded pressure vessels has been verified by testing six 17-in.-diam preflawed Ladish D6A-C test tanks. A brief discussion of technical background illustrates the experimental approach and the significance of resulting test data. A method for utilization of NDT inspection and proof-pressure testing in conjunction with the cyclic flaw growth data for design purposes is also presented. Author

N64-21441 Southwest Research Inst., San Antonio, Tex.
NONDESTRUCTIVE EVALUATION OF METAL FATIGUE Final Report
Felix N. Kusenberger, John R. Barton, and W. Lyle Donaldson 13 Mar. 1964 78 p refs
(Contract AF 49(638)-1147)
(AFOSR-64-0668; AD-600277)

A discussion of the magnetic techniques and magnetic inspection–fatigue tester equipments is presented. The fabrication of Bismuth Hall probes and photographs of one such probe are shown. The design and construction of new electronics for use with the Bismuth Hall probes are summarized. Results obtained from fatigue tests to determine the required stress level for reasonable life were analyzed, and photographs of many fracture surfaces are included. A brief summary of the nondestructive detection of fatigue damage using the magnetic inspection equipment is given. Relationships between magnetic signals and visible fatigue damage prior to failure are presented. The effects of magnetic field strength and static loads applied during inspection on the fatigue damage indications are summarized. A detailed discussion of the inspection results obtained on seven stress cycled specimens is included. Many magnetic inspection records, surface photographs, and graphs illustrating the occurrence and characteristics of the magnetic signals indicating fatigue damage development are presented. Other experiments that include the programed loading of a fatigue damaged specimen and the determination of residual stresses in the vicinity of a fatigue crack are discussed. Author

34 STRUCTURAL DESIGN

Includes structural elements; and weight analysis. *For related information see*: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 33 Stresses and Loads.

N64-21115 Hercules Powder Co., Cumberland, Md. Allegany Ballistics Lab.
EFFECTS OF SAMPLE INERTIA, ELASTICITY OF TEST APPARATUS AND INTERNAL HEAT GENERATION IN THE TENSILE STRESS RELAXATION EXPERIMENT
James H. Thacher Dec. 1963 136 p refs
(Contract NORD-16640)
(ABL-X-106; AD-429300)

The tensile stress relaxation test is widely used to measure the mechanical properties of viscoelastic materials. For certain combinations of test conditions and materials, results from this test will be influenced by sample inertia, test apparatus elasticity, and/or internal heat generation. In this investigation, the magnitude of these effects were estimated, and the test conditions under which they became important are specified. Sample inertia causes longitudinal waves to be generated within the sample upon application of a prescribed end displacement. Wave propagation is described as it relates to the tensile stress relaxation experiment. A nonrigid test apparatus modified the measured relaxation time of the material. The effect of

internal heat generation consists of thermodynamic coupling and heat dissipation terms, which alter the material response. The behavior of a thermorheologically simple material is discussed. The qualitative effect of their inclusion is described. Theoretical solutions for a two-parameter Maxwell material are obtained by the Laplace transform method. Solutions for a real material are formulated by using the Fourier transform approach and various methods of inverting the transform are outlined. Author

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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